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Off-Farm Labour Decisions of Canadian Farm Operators in 2001: The Role of Operator, Farm, Community and Regional Determinants

1991 to 2001

by Alessandro Alasia, Ray D. Bollman, Alfons Weersink and John Cranfield

Agriculture Division
Jean Talon Building, 12th floor, Ottawa, K1A 0T6

Telephone: 1-800-465-1991

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Prepared by
Alessandro Alasia and Ray D. Bollman, Agriculture Division, Statistics Canada
Alfons Weersink and John Cranfield, University of Guelph

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The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{A}	excellent
^{B}	very good
^{C}	good
^{D}	acceptable
^{E}	use with caution
F	too unreliable to be published

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Executive summary

The number of Canadian census-farm operators and the number of these operators reporting off-farm work are trending in the opposite direction. The number of census-farm operators in Canada fell approximately 11% between 1996 and 2001, while the number with off-farm work rose by 6%. The understanding of the factors affecting off-farm labour decisions of census-farm operators has significant implications for rural development and farm income support policy. In this paper, we examine the off-farm labour decisions of Canadian census-farm operators using micro-level data from the 2001 Census of Agriculture combined with community level data from the 2001 Census of Population. The decision to combine off-farm employment with the operation of an agricultural holding is assumed to be affected by the characteristics of the individual, the family, the agricultural holding and the labour market. In this research, specific attention is given to the size of the census-farm in the context of local and regional characteristics that reflect the strength of the job market and the demand of non-farm employment.

While confirming some of the findings of previous research, our results provide an assessment of the differential impact of the determinants of off-farm work participation for operators of smaller and larger holdings. Specifically, human capital and census-farm characteristics play a significant role in off-farm employment for operators of both smaller and larger census-farms. Education is a major determinant of the observed status of off-farm work and the operation of a census-farm holding, but the type of census-farm must be amenable to off-farm work. Off-farm work is more likely to occur when there is more than one operator associated with the farm. Farms with hired workers are larger, and the operator needs to be present to provide supervision, and thus the hired labour appears as a complement rather than as a substitute to farm labour by the operator. Therefore, off-farm work is less likely for operators who hire agricultural labour.

Family, community and regional characteristics appear more relevant in determining the joint decision to work off-farm and operate a smaller holding, compared to the decision to work off-farm and operate a larger holding. This finding parallels the insights coming from the literature on families who operate small agricultural holdings. The results also suggest that, once other factors are accounted for, the proximity to urban centres does not have a positive effect on the joint decision to participate in off-farm work and operate a census-farm. This joint decision, in fact, is more related to the dynamics of the local labour market. These findings suggest that while urban centres might represent an engine of growth for overall rural income, through employment opportunities for the non-farm workforce, the non-farm income of census-farm operators is more likely to be affected by policy initiatives that directly address the dynamics of labour markets in the community where the operator lives.

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1. Introduction

The number of Canadian census-farm operators and the number of them reporting off-farm work are trending in the opposite directions. Between 1991 and 2001 the number of census-farm operators fell by approximately 11 percent, from 390,870 to 346,195 individuals. Over the same period, the number of operators reporting off-farm work rose approximately 6 percent, from 145,005 to 154,215 individuals (Statistics Canada 2002a). Similar indicators, such as the share of census-farm operators working full-time off the farm and the contribution of off-farm income to total family income for farm households, point to the long-term structural shift in rural employment away from agriculture and to the growing income diversification of families associated with census-farms. Although the share of census-farm operators engaged in off-farm work has fluctuated around 30 percent since the 1940s, the relevance of farm employment has declined for both rural households and rural communities (Bollman 1979; Bollman and Biggs 1992). Multiple job-holding by farm households has become a common pattern across rural Canada (Fuller and Bollman 1992), with the service sector being the main source of employment for rural residents (Bollman et al. 1992).

In the emerging rural economy, off-farm employment can have different connotations. First, engaging in off-farm employment can be a self-insurance mechanism for households associated with an agricultural holding to help stabilize total household income given the inherent variability in net farm revenue. Second, off-farm employment may be necessary to provide sufficient income to cover family living expenses if the operator of the farm is unable to generate enough revenue to support a family (for example, in cases where the operation is too small or the operator lacks the required management skills). Third, off-farm labour may in fact be the primary household employment for rural residents who have chosen a rural lifestyle and, due to some agricultural sales, are recorded as operating a census-farm[1].

While these conditions can hardly be disentangled using the available cross-sectional data, farm size is likely to be a major variable in determining the essential connotation of off-farm labour participation. Smaller census-farms are less likely to provide sufficient and stable income for the household and are more likely to be associated with rural lifestyle choices in which farming becomes a secondary economic activity for the households. Indeed, national statistics from the Census of Agriculture show a striking difference in off-farm labour participation by size of the operation (Statistics Canada 2002a). In 2001, 93 percent of operators reporting off-farm work were associated with census-farms that generated less than $250,000 in total gross farm receipts. Similarly, about 86 percent of the operators working off the farm were associated with a census-farm with total capital of less than $1 million (Table 1).

1. A census-farm is defined as "a farm, ranch or other agricultural operation which produces at least one of the following products intended for sale: crops, livestock, poultry, animal products, greenhouse or nursery products, Christmas trees, mushrooms, sod, honey and maple syrup products." (Statistics Canada 2003:6). The definition of farm operator "refers to those persons responsible for the day-to-day management decisions made in the operation of the census farm." (Statistics Canada 2003:7).

Previous research and theory suggest that the characteristics of the individual, the farm and the region in which the individual lives can enhance our understanding of the determinants of the labour allocation decisions of operators who combine farm and off-farm work. However, the existence of such different motivations behind the choice to combine operating a census-farm and working off the farm – particularly as an income level or stabilization objective versus potential rural lifestyle choice – suggests that specific attention should be paid to the size of the farm. Besides using farm size indicators as explanatory variables in the model, it is worthwhile exploring the use of farm size characteristics as classification criteria for sub-sample estimates. This suggests potential for a differential effect of various mitigating and motivating factors in relation to off-farm labour market participation based on farm size. Analysis of sub-samples delineated by farm size enables one to determine if labour market behaviour by small farm operators differs from that of large farm operators.

The relative importance of individual, farm, and regional factors has significant implications for rural development and farm income support policy. For example, if off-farm labour participation of farm households is determined largely by institutional factors, such as labour market conditions, and if the policy objective is to augment the household income via participation in off-farm employment, then the policy focus should be on economic development in the rural area. In contrast, the focus should shift to human capital development if off-farm work was primarily determined by personal characteristics. Understanding determinants of the decision to participate in off-farm employment can also help in designing outreach programs for members of households who want to increase their incomes where one member of the household is operating a census-farm.

In this paper, we examine the off-farm labour decisions of Canadian census-farm operators using micro-level data from the 2001 Census of Agriculture combined with community level data from the 2001 Census of Population. Compared with previous research on off-farm employment, this paper enhances our understanding of off-farm labour allocation by investigating explicitly the differential impacts of the various factors for households associated with a "smaller" and a "larger" census-farm. We account for the regional dimension of the labour market and explore rural-urban interactions in determining employment outcomes. We use a set of spatially lagged covariates which allow us to assess the effect of regional characteristics on off-farm labour decisions for households that have chosen to operate a census-farm. We begin by deriving the major characteristics influencing the participation decisions through a household production model. The following section presents the empirical model including a description of the variables and their hypothesized effects. The paper concludes with the results and implications of the findings.

2. Theoretical framework

An individual will operate an agricultural holding if the marginal revenue product for the first hour of self-employed work is greater than the wage rate in an alternative endeavour (Bollman, 1978). This individual will work off the farm if the wage rate offered in the market is greater than the marginal revenue product of farm work evaluated at the intersection of the individual's marginal revenue from farm work and the individual's (total) labour supply function (Bollman, 1979). The relative values for the off-farm wage rate available to the individual and the reservation wage (i.e. the total labour supply curve of the individual) depend on the prevailing labour market conditions and the individual's characteristics. The effect of these variables on the decision to participate in off-farm work, for individuals observed to be operating an agricultural holding, can be derived through the solution to a household production model in which the farmer maximizes utility derived from purchased goods (G) and leisure (L). The utility obtained from G and L depends on human capital (H) and family characteristics (Z), such as age and the presence of children in the family:

$$U=U(G,L;H,Z) \qquad (1)$$

The total and relative amounts of goods and leisure are constrained by the total amount of time available to the farm operator (T). The farmer's time can be allocated to leisure or to work, which can be done on the farm (F) or off the farm (M), $T=L+F+M$. Working in either activity generates income that can be used to purchase consumable products. Increases in farm work are assumed to increase farm output (Q) but at a decreasing rate as summarized by the following production function:

$$Q=Q(F,HF,X:H,K) \qquad (2)$$

where HF is the hours of hired workers, X is a vector of variable inputs and K is a vector of farm characteristics, such as farm type and business organization. In addition to affecting farm output, increases in human capital (H) are also assumed to increase the wage that can be earned in off-farm employment. The market wage (W) will also depend on regional market characteristics (R), such as industry structure and unemployment rate, as follows:

$$W=W(H,R). \qquad (3)$$

Given the labour productivity relationships for farm and off-farm work, along with the identity for total labour allocation, the financial resources available to spend on consumption goods can be expressed as:

$$P_G G=P_Q Q - P_{HF} HF - P_X X + WM + V \qquad (4)$$

where P_G is the price of good G and V is the amount of other household income. Solving the budget constraint in terms of G and the time constraint in terms of L and substituting into the utility function, results in an unconstrained optimization problem with the choice

variables being the amount of time allocated to working on the farm or off-farm and farm inputs, including hired work. Simultaneously solving the first order conditions determines the optimal levels of those choice variables (see Huffman 1991; Weersink 1992).

This analytical framework can be applied for the analysis of off-farm labour participation, for individuals who have already chosen to operate an agricultural holding. The individual will not work off-farm if the marginal return to market employment, assumed to be the wage rate (W), is less than the marginal value of farm labour evaluated at the optimal point with no off-farm work. Thus, the off-farm employment decision by a farm operator can be summarized as:

$$M>0 \text{ if } W(H,Z,R)>P'Q_F(H,Z,K)|_{F=0} \text{ and} \qquad (5)$$
$$M=0 \text{ if } W(H,Z,R)\leq P'Q_F(H,Z,K)|_{F=0}$$

where M is the level of off-farm labour market participation. For convenience in later sections, the terms in the inequality conditions in (5) can be specified as:

$$W^* = W(H,Z,R) - P'Q_F(H,Z,K)|_{F=0} \qquad (6)$$

where W^* represents the opportunity cost of off-farm labour. The optimal amount of farm work is where the incremental value of extra time on the farm is equal to the marginal rate of substitution between leisure and consumption (U_L/U_G). If the wage rate is greater than the marginal returns to farm work, then the farmer will engage in off-farm employment until the incremental returns to both forms of employment are equated to U_L/U_G. Since the work allocation between farm and off-farm is determined jointly, the decision to participate in off-farm employment is a function of all exogenous variables in the household production model: human capital (H), family (Z), farm (K), and market (R) characteristics.

3. Model specification and estimation

Model specification requires the identification of an appropriate functional form for estimation and the definition of operational variables that reflect the underlying theoretical concepts. The derivation of an econometric model from our theoretical framework is presented in Section 3.1. Details on the data source and variable definitions are presented in Section 3.2, while the last section presents in detail the computation of spatially lagged variables.

3.1 Derivation of the econometric model

To move to estimation, the theoretical model derived in the previous section has to be assigned an explicit functional form. Assuming that the implicit functions of equation (6) can be represented by linear relationships, and using P as numeraire (i.e., P =1), we can write:

$$W_i^* = \gamma_1 H_i + \gamma_2 Z_i + \gamma_3 R_i + \varepsilon_i - \delta_1 H_i - \delta_2 Z_i - \delta_3 K_i + \nu_i \quad (7)$$

where W^* denotes an ideal, continuous, variable measuring the opportunity cost of off-farm labour, γ and δ are sets of parameters for market wage and farm returns respectively, H, Z, K and R are sets of explanatory variables as specified in the previous section, ε and υ are the disturbance terms, and i denotes the subscript of the observation, i =1,2,..., n. We can simplify equation (7) by setting $\beta=(\gamma-\delta)$, $u=(\varepsilon-\upsilon)$, and ignoring the signs of the generic variables for the time being; as a result, we yield:

$$W_i^* = \beta H_i + \beta Z_i + \beta R_i + \beta K_i + u_i \quad (8)$$

Ideally, equation (8) would represent the model to be estimated. In reality, however, W^* is not observable. The reservation wage (derived from the individual's total labour supply function) that determines off-farm labour participation cannot be measured. Moreover, the available data from the Census of Agriculture do not allow measurement of off-farm labour allocation as a continuous variable. Typically, off-farm labour participation is recorded as a categorical outcome, that is, participation or non-participation in off-farm labour.

The characteristics of this problem and the focus of this study are suited for qualitative dependent variable modeling (Long and Freese 2001). Following this approach, equation (8) can be assumed to represent a latent model, which is not observable in reality, but which can be related to an observable model in which the dependent variable takes a dichotomous outcome. In general terms, the underlying latent model takes the form:

$$y_i^* = \mathbf{x}_i \beta + u_i \quad (9)$$

The relation between the unobservable variable ($y^*=W^*$) and the observable outcome ($y=M$) is summarized by a measurement equation, which can be derived from equation (5) and, in general terms, can be expressed as follows:

$$y_i = \begin{cases} 1 \text{ if } y_i^* > 0 \\ 0 \text{ if } y_i^* \leq 0 \end{cases} \quad (10)$$

Conventionally, y is coded as 1 if y^* is reported as a positive amount and 0 if y^* is equal to zero or negative. It follows that the conditional expectation $E(y|\mathbf{x})$ can be interpreted as a conditional probability that the outcome of interest will occur, $Pr(y|\mathbf{x})$. Hence, from equations (9) and (10), dropping the observation subscript for simplicity, it follows that:

$$\Pr(y = 1 \mid \mathbf{x}) = \Pr(y_i^* > 0 \mid \mathbf{x}) \quad (11)$$

Assuming the latent variable can be expressed as $y^* = \mathbf{x}\beta + u$, where $\mathbf{x}$ is a (1xn) vector of explanatory variables, β is a n-vector of parameters and u is an error term, then (11) can be expressed as:

$$\Pr(y = 1 \mid \mathbf{x}) = \Pr(u > -\mathbf{x}\beta \mid \mathbf{x}) \tag{12}$$

Equation (12) shows that the probability of the event depends on the distribution of the error term u, which is typically unknown. Although a variety of assumptions can be made about this distribution, applied research has typically adopted two alternatives: probit or logit distribution. In this research we use a probit specification.[2] The probability of an observation (census-farm operator) belonging to one of two mutually exclusive groups (off-farm work versus no off-farm work) is defined by the integration of the normal probability density function, *N(0,1)*, between -∞ and a linear function of the independent variables ($\mathbf{x}\beta$). The specification of the model is as follows:

$$\Pr(y = 1 \mid \mathbf{x}) = \int_{-\infty}^{\mathbf{x}\beta} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{u^2}{2}\right) du = \Phi(\mathbf{x}\beta) \tag{13}$$

where y is the vector of independent binary outcomes assumed to be mutually exclusive and exhaustive, and $\Phi(.)$ denotes the cumulative normal distribution function (cdf).

In summary, the observable dichotomous variable M takes the value 1 when the operator reports off-farm labour and takes the value 0 otherwise. The set of explanatory variables ($\mathbf{x}$) includes individual, family, characteristics of the agricultural holding and community level variables, hence we can write:

$$\Pr(M = 1 \mid \mathbf{x}) = \Phi(\beta_1 H + \beta_2 Z + \beta_3 K + \beta_4 R) \tag{14}$$

Equation (14) represents the probit specification used in this study, which is estimated using maximum likelihood methods in STATA.

3.2 Data and variables selection

The model in equation (14) is estimated using micro-data combined with community data aggregated at the Census Consolidated Subdivision (CCS) level. Micro-level data are from the Census of Agriculture-Population Linkage database 2001, which links information for a 20 percent sample of operators, as identified in the Census of Agriculture, with their socio-economic information collected from the Census of Population. This database includes 70,851 census-farms operators, of which we excluded 513 operators in collective dwellings (which would largely be residents in Hutterite Colonies). Community level data are from the 2001 Census of Population, tabulated for constant 1996 census geography; this corresponds to 2,607 CCSs. [3] For the variables used

2. Probit models assume a normal (0,1) distribution of the error term; logit models assume a logistic distribution of ε , with mean of 0 and $\text{Var}(\varepsilon) = \pi^2/3$. The coefficients generated by the two models differ in magnitude, normally by a fixed proportion, but the differences in probability outcomes are generally marginal. Thus, for practical purposes, the two specifications are equivalent and the choice among the two is driven by authors' preferences and practical computational reasons.

3. A Census Consolidated Subdivision (CCS) is a grouping of adjacent Census Subdivisions (CSD), except for CSDs with population over 100,000 which form CCSs on their own. Generally, the geographically

in this research, data was available for 2,382 CCSs (1996 census geography) because community data could not be tabulated for CCSs with population less than 250 individuals for data quality and confidentiality reasons. The combination of the Agriculture-Population Linkage database and community level database yielded the data set used for estimation, which encompassed 69,797 farm operators and 1,746 CCSs out of 1,783 CCSs (2001 census geography) for which Census of Agriculture data was collected.[4]

The model is estimated for two sub-samples, corresponding to operators associated with smaller and larger census-farms. We define operators of smaller census farms as those reporting total gross farm receipts of less than $250,000 for the census year. This sub-sample corresponds to 58,212 operators (83 percent of the total sample). Operators of larger census farms are defined as those with total gross farm receipts equal to or greater than $250,000 for the census year; this corresponds to 11,585 operators (17 percent of the total sample).

For individuals who operate a census-farm, the decision to participate in off-farm employment is assumed to be affected by individual, family, farm characteristics, local and regional labour market characteristics. We use a total of 60 variables to capture these effects. A technical description of the variables used in the model is provided in Table 3. In the following, we provide a concise description of these variables, along with the rational for their use and the expected effect.

Human capital theory suggests that the marginal productivity of any self-employed operator will increase with socio-economic factors such as age (i.e. experience) and education (i.e. analytic capacity). Although both the off-farm wage rate that can be earned by the operator and the incremental value of farm work should increase with human capital, previous studies have generally found the relative effect larger for off-farm employment. The age of the operator is included as a quadratic variable since it is assumed that more experience increases the relative employability of the operator in the off-farm labour market, but there comes a point when the individual may not be able to handle the tasks or to adjust to new skills as well as a younger person. Age may also indicate whether off-farm work is a transition stage if those with off-farm employment tend to be younger and full-time farmers are older.

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smaller and more urban CSDs (towns, villages, etc.) are combined with the surrounding, larger and more rural CSDs. This aggregation generates spatial units which represent more closely a functional area and are at an intermediate level between the municipality (CSD) and the region (Census Division). Details on the definition of Census Consolidated Subdivision are available on the Statistics Canada web site at: http://geodepot.statcan.ca/Diss/Reference/COGG/Index_e.cfm

4. Two things should be noted. First, between 1996 and 2001 significant boundary changes were made to CCSs, particularly in Britis. Columbia and Ontario. As a result, the total number of CCSs dropped from 2,607 in 1996 to 2,446 in 2001. Since the Agriculture-Population Linkage database used the 2001 census geography, some of the CCSs defined on the 1996 geography had to be re-aggregated when merging the two files. In these cases, the simple average of the indicator of interest was used. Second, it should be emphasized that all the spatially lagged variables are computed on the whole 2,382 CCSs (1996 geography) for which community data are available. This implies that the regional effects estimated in the model do capture the socio-economic conditions of neighboring CCSs for which no farming population is recorded (many of which are likely to be urban CCSs).

For female individuals who are recorded as being an operator of a census-farm, a lower rate of participation in off-farm work may indicate relative discrimination against females, which may be more prevalent in rural labour markets (Phimister et al. 2002). Education is measured by four dummy variables representing the highest level of schooling attained by the operator with the base variable being less than high school. Higher education levels have been associated with higher wage levels in rural Canada (Vera-Toscano et al. 2003). Following the findings of other studies, it is expected that the available off-farm wage will be higher than the return to farm work for operators with higher levels of educational attainment.

Family characteristics include the presence of young children, mobility status, and amount of time spent in domestic work. The reservation wage of the operator is assumed to increase with children in the family since the value of home time is increased relative to the time spent working. However, having young children may increase the financial needs of the family and thus may prompt the necessity for additional income from farm or off-farm work. The costs of searching for employment and the adjustment costs for re-location are assumed to decrease, and thus the likelihood of off-farm employment to increase, if the family has moved previously. Engagement in domestic work may also affect off-farm labour decisions. Even though there is limited theoretical indication on the potential effect of these variables we include engagement in housework, child and senior care as control variables.

Characteristics of the census-farm holdings include the type of farming operation. Excess labour available for off-farm employment will decrease with the labour requirements on the farm and these requirements are more likely to be higher for livestock operations such as dairy and hog farms that require daily efforts than for crop farms where labour needs are largely seasonal. The joint operation of a census-farm holding and participation in off-farm work is expected to be largest for holdings that are easiest to operate on a part-time basis – such as beef cattle or horses (which may, in fact, be pets rather than animals for sale).

Increasing the number of operators on the farm is assumed to increase the likelihood of off-farm employment since the constraint on labour availability is relaxed. Similarly, alternative business structures may be more conducive to working off the farm. A partnership or corporation may increase farm productivity through labour specialization and thus decrease the likelihood of off-farm employment (Rosen 1978) or the specialization may delineate the roles of investor and operator in which case the former may also be involved in non-farm employment.

Increases in farm size as measured by land area or asset value are assumed to increase the marginal productivity of farm labour used on the farm and subsequently lower the probability of working off the farm. The incremental value of farm labour may also be increased through hired workers that allow for specialization of the operator in more management-related activities. While hired labour could be a complement to the labour time spent on the farm by the operator as supported by Benjamin et al. (1996) and

Bollman (1979a), it could also serve as a substitute and allow the operator to work for market wages higher than that which would be paid to the farm employees.

Local and regional characteristics reflect the strength of the job market and institutional factors affecting both the demand and supply of non-farm employment. We distinguish between *local* and *regional* effects by using community level variables and their corresponding spatially lagged variables (details on the computation of the spatially lagged variables are presented in the next sections). For instance, the unemployment rate of the community in which the farm operator is located proxies the strength of the labour market at the local level. Although the local dimension might be critical in determining employment outcomes of farm operators, an alternative hypothesis is that the conditions of the regional labour market may have a greater bearing in affecting off-farm employment outcome. The inclusion of local and spatially lagged (regional) variables allows us to explore this dimension. Besides unemployment, total employment growth and incidence of manufacturing and service industries has been indicated as a relevant explanatory variable of engagement in off-farm labour (Findeis et al. 1991). We use total employment change, in percentage terms, at the local and regional level between 1991 and 2001. Labour market demand characteristics are proxied by the industry employment shares in 2001, at the local and regional level; eight industry groups are used, which include four manufacturing groups and four service industry groups. If a region is home to primarily low-paying service jobs, then the relative value of the market wage opportunities will be less and thus so will the likelihood of off-farm employment. The Herfindahl Index of concentration was also used to capture the degree of employment specialization of a locality and region. It is expected that less diversified economies offer less opportunities for off-farm employment.

Finally, the size of the labour market and its density can affect the likelihood of off-farm employment. We include two measures of urbanization to assess these potential effects: the distance to an urban centre, in its linear and quadratic form, and population density at the local and regional level. Agglomeration economies associated with reduced transport costs to work and a greater variety of employment opportunities could be expected to increase the relative value of off-farm employment in more urbanized areas (Glaeser and Mare 2001). In contrast, rural areas are more likely to have higher search costs for employment, more occupational mismatches, and fewer job training opportunities (Wheeler 2001; Findeis and Jensen 1998). The existing literature, however, indicates that urbanization factors are not always clear predictors of off-farm labour decisions (Findeis et al. 1991) and research is limited in the Canadian context.

3.3 Specification of the spatially lagged variables

As mentioned in the previous section, we identify two components of the regional milieu effect: the *local* effect and the *regional* effect. This distinction is introduced by means of CCS variables, to capture the effect of local characteristics, and their corresponding spatial lag, to capture the regional effect. For each CCS and indicator of interest, the spatial lag is a weighted average of the neighboring CCSs' values for that given indicator. The computation of the spatially lagged variables requires some clarification.

In general terms, the computation of spatial lags involves three steps. First, a spatial weight matrix **W** is computed using some proximity criteria between units of observation (CCS in our case). The elements w_{ij} of the squared matrix **W** defines the nature of the spatial relationships among the geographical units *i* and *j*. Hence, the specification of the weight matrix **W** is of particular relevance in spatial analysis since it defines the extent of the regional effects. There are alternative ways in which the matrix can be specified and relatively limited theoretical guidance is available for choosing among them (Anselin 1988). Typically, while the choice rotates around alternative definitions of boundary proximity or geographic distance, it is common practice to assess the robustness of the analysis testing the effects of alternative specifications of the weight matrix (Boarnet et al. 2005). Second, the spatial weight matrix is row standardized; the elements of each row are scaled so that the rows sum to one, resulting in a form of spatial smoothing. Finally, the **W** matrix is used to compute spatially lagged variables (*x_lag*), by multiplying the *(nxn)* **W** matrix with the *(nx1)* vector of the indicator of interest.

For the problem at hand, a distance measure between territorial units appears more appropriate than a boundary criteria to define spatial relationships. Hence, the procedure used to compute the matrix is as follows:

$$\begin{cases} w_{i,j} = 1/d_{i,j}^{\alpha} \quad for\ i \neq j\ and\ d_{i,j} \leq D \\ \qquad w_{i,j} = 0 \quad otherwise \end{cases}$$

$$w_{i,j}^{s} = w_{i,j} \Big/ \sum_{j} w_{i,j} \qquad (15)$$

$$x\_lag_i = \sum_{j} w_{i,j}^{s} \cdot x_j$$

For $i \neq j$, the element w_{ij} of the spatial weight matrix is set equal to the inverse of the linear distance (*d*) between each pair of CCS's geographic centroids, while for $i=j$ the element is equal to zero, implying that the diagonal of the matrix is 0. In this way, the value of each observation (local context) is not included in the computation of the corresponding spatial lag (regional context). The inverse-distance weight replicates a gravity model principle, with larger distance resulting in a smaller value of the spatial weight, w_{ij}, which in turn implies a weaker spatial interaction. The gravity effect can be amplified or reduced by changing the parameter α, which is typically set equal to 1, 2 or 3. In this analysis we use the inverse of the squared distance as the basic specification.[5] It is also common practice to set a threshold distance after which spatial interaction is supposed to disappear. In our analysis, the bandwidth (*D*) of regional interaction is set equal to 1,000 kilometers.[6]

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5. It should be noted that when $1/(d_{ij})$ and $1/(d_{ij}^{3})$ were used instead of $1/(d_{ij}^{2})$ the results of the analysis were virtually identical.
6. The choice of this bandwidth is dictated primarily by a computational consideration; this value is slightly above the minimum distance that allows each observation to interact with at least one regional neighbor; in other words this avoids the presence of an unconnected "island", which would result in an entire row of zero values.

4. Estimation results

The results of the probit estimates, for the full sample, as well as for operators of smaller and larger census-farms are presented in this section. We start with an overview of descriptive statistics for the variables used in the model, which also allows us to compare some of the sample statistics with national statistics from the Census of Agriculture. The following discussion on model results focuses on overall model statistics and the testing of coefficients. The numeric value of probit model coefficients provide only limited information on the relationships between dependent and independent variables due to the functional specification and the non-linearity of the model. For this reason, further computations are required to gain a better understanding of this relationship, which will be the specific focus of Section 5.

4.1 Summary statistics

Summary statistics for the variables explaining off-farm employment are given in Table 4, for the full sample, and Table 5 for the sub-samples of the operators of smaller and larger census-farms. These statistics are for the unweighted sample used in our analysis and therefore they should not be interpreted as national averages.[7] Nonetheless, sample statistics are generally in line with national statistics, particularly for operator attributes. For the interested reader, national statistics generated from the Census of Agriculture and the Agriculture-Population linkage database are reported in Table 1 and 2, for a set of operator and farm indicators comparable to those used in this analysis. The following discussion focuses on sample statistics (Table 4 and 5).

Both full sample and sub-sample statistics provide interesting insights. The different incidence of off-farm work for operators of smaller and larger farms shows that almost half of the operators of smaller census-farms report off-farm employment, compared to about 20 percent of the operators of larger census-farms. The census-farm operators working only on the farm tend to be older, less educated, and report lower (farm plus non-farm) income compared to those individuals who combine farm and off-farm work. These differences hold for the operators of both smaller and larger census farms, although they are generally more pronounced for the former type (for instance, 55 versus 46 years of age, 48 percent versus 27 percent without a high school diploma). There are also sizable differences in the means for the family characteristics. Operators working off the farm are more likely to have young children (39 percent versus 27 percent, for the full sample) and a higher share had changed their residence within the previous five years.

7. The Census of Agriculture applies two types of sample weights, one for the census-operators and the other for the census-farm. All the statistics presented in this paper are unweighted; this is in line with the decision to adopt an unweighted procedure for the estimation. The choice of an unweighted estimate was motivated by the challenges posed by the combination of the two sample weights for different types of variables. Moreover, the use of sub-sample estimates, for smaller and larger census-farms, mitigated the need to adopt weighting procedures. Finally, to test the robustness of the results we performed weighted estimates with the two alternative sample weights; the results were substantially identical to the unweighted regression and are available from the authors upon request.

As expected, operators with no off-farm work are more likely to be operating dairy census-farms than those types of holdings where excess labour opportunities may exist, such as cattle and field crop enterprises. Operators with some off-farm employment are more likely to be associated with partnership farms than operators with no off-farm work. The average farm size is approximately twice as large for those census-farms of operators working only on the farm compared to those with some off-farm employment. The extent of hired workers used on the farm is also significantly higher for farms operated by full-time census-farm operators.

The differences in the averages among local and regional labour market characteristics between employment categories appear generally small. The difference in average employment growth of a locality does not appear to have a consistent association with off-farm employment status. In contrast, operators of both smaller and larger census-farms reporting off-farm work are on average located further away from urban areas and in a locality with lower population density, compared to operators with no off-farm work.

4.2 Probit estimates

The estimated coefficients of the probit model for the full sample, smaller, and larger holdings, are listed in Table 6, 7 and 8 respectively. Each table shows the estimated coefficients and the associated marginal effects. These are reported for completeness but, as previously mentioned, the impact of variable changes on the probability of off-farm work will be discussed in detail in the next section. Following the insights of Long and Freese (2001) on possible misspecifications in the binary model, such as the choice of the functional distribution of error terms, we use White robust standard errors that are considered to provide robust inference in the presence of violations of the model's assumptions.

Overall model statistics are reported at the bottom of each table. The full sample model fits the data reasonably well as indicated by the pseudo-R^2 values comprises between 0.19 (Likelihood ratio index) and 0.38 (McKelvey and Zavoina's R^2); most of the explanatory variables are both statistically significant and have signs consistent with theory. In addition, the full sample model predicts that 41 percent of the operators will engage in off-farm employment as compared to the observed 44 percent. However, the differences between the model for operators of smaller and larger census-farms are substantial, both in terms of model statistics as well as single explanatory variables.

Three major results emerge from the alternative estimates. First, high human capital characteristics, and specifically educational attainment, are always associated with a greater likelihood of being employed off-farm. Second, for operators of smaller and larger holdings, the effect of farm size shows a similar pattern indicating an inverse and significant relationship between farm size and off-farm employment (although variations in farm size is less relevant for the sub-sample of farms that are selected for being relatively large). Third, family and regional characteristics appear more important in determining the choice to jointly work off-farm and to operate a smaller census-farm than

the similar choice for a larger farm. The remainder of this section discusses the results in further detail.

Individual characteristics. Human capital variables, and in particular the level of educational attainment, have the expected effects on off-farm employment. In all estimates, the linear coefficient for age is positive, while the quadratic term is negative. Yet, the age coefficients are not statistically significant for operators of larger census-farms. These results suggest that off-farm employment is not a transition stage for younger farmers on their way to establishing full-time farm operations but rather a permanent situation for either life-style or financial reasons. The fact that age is only significant for operators of smaller census-farms may suggest that at a given point of time (2001), older individuals were more likely to have bought a hobby farm to combine with the off-farm work. Education has a significant positive impact on off-farm work and highlights the importance of human capital in predicting whether the operator works off-farm, regardless of farm size.

Family characteristics. Some variables representing family characteristics are statistically significant only for operators of smaller census-farms, while none of the family characteristics have significant effects on off-farm labour allocation of operators of larger census-farms. Surprisingly, the presence of children under the age of 15 has no significant effect on off-farm labour decisions in the sub-sample estimates, although it has a negative and significant effect in the full sample model. Similarly, the involvement in unpaid child care has no significant effect in any of the estimated models. In contrast, engagement in unpaid senior care and housework reduce the likelihood of working off the farm. The full sample model suggests that operators that have moved recently are more likely to have outside employment, but the significance of this variable vanishes in the sub-sample estimates.

Characteristics of the census-farm holding. The effect of the characteristics of the census-farm is similar across the three estimates. Operators associated with dairy farms are less likely to have off-farm employment compared to operators of any other type of farm, which is consistent with the heavier, daily labour requirements for dairy farms relative to others. Off-farm employment also increases with the number of operators on the farm. The more operators (i.e., decision-makers) involved in a farm of a given size, the greater the potential for excess farm labour for the "observed" operator that can be used for off-farm work. However, increasing the complexity of the business structure apparently increases the value of on-farm work by the operator and decreases the probability of off-farm employment compared to a sole proprietorship; this is particularly evident for corporations. Increasing the size of the operation, in terms of land area, capital investment, and sales, has a significant effect in reducing the likelihood of off-farm employment, however, for all three variables the effect is not linear; beyond a threshold point the likelihood of being employed off the farm increases again. These results appear consistent with the effect of hired labour. Hired workers are a complement to labour time spent on the farm by the operator as opposed to being a substitute input. The finding suggests that outside help allows the operator to specialize and thereby increases her/his incremental value of farm labour relative to off-farm employment. The

results of the quadratic term suggest that beyond a certain threshold, hired labour does become a substitute for the operator's own farm labour; however, the nature of this non-linear relationship will be further discussed when presenting the effect of discrete variable changes on the probability of off-farm labor (Section 5.1).

Local and regional characteristics. The effect of the local and regional variables shows the relevance of the territorial context in determining occupational outcomes of census-farm operators. The results clearly suggest that local and regional context are more important for the observation of combining off-farm work and operating a smaller holding compared to combining off-farm work and operating a larger holding. Overall, the indicators that measure the strength of the local and regional labour markets (employment growth, unemployment rate, and economic diversification) have the expected effects, although they are not always statistically significant. The local employment change between 1991 and 2001 consistently has a positive and significant effect on the likelihood of farm operators working off-farm, while a more diversified regional economy (i.e. less specialized) and a lower regional unemployment rate increase the likelihood of engaging in off-farm employment for operators of smaller farms. For operators of larger holdings, the unemployment rate shows a more ambiguous result: while high local unemployment rates have a negative effect on off-farm employment, high regional unemployment rates are associated with a higher likelihood of employment off-farm. Although this result remains difficult to interpret, a plausible conjecture is that regional unemployment captures the effect of neighbouring, more urbanized, communities with relatively high concentrations of unemployment.

The employment structure of the community and region of residence of the operator has a mixed effect on the likelihood of off-farm employment, and generally this effect is only evident for operators of smaller operations. For manufacturing, significant and positive effects are found for local employment in labour-intensive and scale-based manufacturing; but these seem contrasted by negative and significant effects of regional employment in product differentiated/science based manufacturing and labour-intensive manufacturing. For the service sector, significant and positive effects are found for local employment in consumer services and regional employment in business services, but a high concentration of regional employment in consumer and distributive services has a negative effect on the probability of off-farm employment. In the bottom part of Tables 6, 7 and 8 we report the results of alternative hypothesis tests on local and regional coefficients; a Wald test is used in all cases. These results show that, for operators of larger census-farms (Table 8), the null hypothesis that regional coefficients are simultaneously equal to zero cannot be rejected at standard significance levels, confirming that these variables are less relevant for operators of larger census-farms.

Urbanization. The degree of urbanization, as measured by the distance of the farm from an urban centre and population density, appears to complement and provide further insights to the results on local and regional employment structure. The results generated by urbanization variables are relatively consistent, in terms of directions of the effect, for operators of smaller and larger census-farms, although statistical significance is evident only for the former. At the same time, these results seem to contradict some of the

expectations. For operators of smaller census-farms, high population density of the region of residence is associated with a lower probability of working off the farm. This finding is reinforced by the results on distance to urban centres: contrary to what it could be conjectured on rural-urban linkages, once other factors are accounted for, the likelihood of off-farm employment is higher for operators located further away from urban centres (i.e. CMA/CA).

5. Effect of covariate changes on the probability of off-farm labour

Probit models imply a non-linear relationship between the explanatory variables and the dichotomous dependent variables, which is defined by the cumulative distribution function $\Phi(.)$. Since the model estimates the conditional probability $Pr(y|x)$ of off-farm labour participation, non-linearity is in fact a desirable property. For example, if we assume that farm size has a negative effect on the probability of the operator working off the farm, it is plausible to expect that for very small farms (implying $Pr(y=1)$ close to 1) an additional acre would hardly change the sign of W^* and thus the attitude of operators toward her/his off-farm work. Within an intermediate range of farm size it is plausible to expect that an additional acre will have a larger impact on the probability of off-farm labour, while again for an operator of a large farm, when $Pr(y=1)$ is close to 0, an additional acre could not reduce any further the probability of off-farm work. This relationship is well captured by the typical "S" shaped profile of the normal cumulative distribution function.

The challenges posed by this specification, however, are several. Besides the fact that the coefficients have no direct interpretable substantive meaning, the magnitude of change in the predicted probability associated with a given change in one of the explanatory variables depends on the values of all explanatory variables, and must be evaluated at a given value of $\mathbf{x}$. There is no single approach that can be used to summarize the complexity of these relationships (Long and Freese 2001). In this paper we use a combination of conventional and more original methods to generate an in-depth understanding on how changes in explanatory variables may affect the probability of off-farm labour.

Conventionally, the marginal effects are used to display the relationship between single explanatory variables and the probability of a certain outcome. For continuous variables, the marginal effect (m) of the k explanatory variable represents the change in probability due to an infinitesimal rate of change in x_k; that is the slope of the prediction function. This value can be derived from the equation (10), and is equal to the following:

$$m_k = \frac{\partial \Pr(y=1|\mathbf{x})}{\partial x_k} = \frac{\partial \Phi(\mathbf{x}\beta)}{\partial x_k}\beta_k = \phi(\mathbf{x}\beta)\beta_k \qquad (16)$$

where $\phi(.)$ represents the standard normal probability density function and the rest is as previously defined. Equation (16) clearly shows that, unlike the standard regression which has constant marginal effects equal to the regression coefficients, the marginal

effects in a probit model are non-linear and dependent on the level of all explanatory variables, **x**, at which they are evaluated. In practice, the marginal effects are usually evaluated holding other variables at their sample means, which is the procedure that we used for the values reported in Tables 6, 7 and 8.

As a result of non-linearity, the marginal effect is not always the best indicator of a probability change due to substantively meaningful variations of the explanatory variables. In several instances, the marginal change, m_k, is substantially different from the probability change that would result from a small discrete variation of x_k.[8] For this reason, we pay greater attention to the effect of discrete changes of the independent variables. We computed the probability associated with specific values of the explanatory variables and then compute the difference between the predicted probabilities of these "typical cases". Thus, for a discrete change of x_k the associated probability change is given by the following:

$$\frac{\Delta \Pr(y=1 \mid \mathbf{x})}{\Delta x_k} = \Pr(y=1 \mid \mathbf{x}, x_k + \delta) - \Pr(y=1 \mid \mathbf{x}, x_k) \qquad (17)$$

where δ represents the discrete change of x_k and the rest is as previously defined. The computation is done by keeping all other explanatory variables at their sample means.[9]

Using this approach, we evaluate the probability of off-farm labour at minimum (x_{min}) and maximum (x_{max}) values for each explanatory variable, and the corresponding probability change between these two values.[10] For continuous variables, we computed also the probability change associated with one standard deviation (*sd*) change of the explanatory variable centered around its mean (μ). Hence, we evaluate the probability at values of $x=\mu-(\alpha \cdot sd)$ and $x=\mu+(\lambda \cdot sd)$, where α , $\lambda > 0$ and $\alpha + \lambda = 1$. For the variables that are approximately normally distributed, we set the value of α and λ equal to 0.5, hence $x=\mu+/-(1/2 \cdot sd)$. For the variables that have a skewed distribution, we use the value of α=0.1 and λ=0.9, which avoid computing the probability associated to a negative value of x.[11]

These computations are complemented with graphical analysis, which is particularly revealing for the continuous variables that include a quadratic term. We plotted the predicted probability of off-farm labour for plausible ranges of values for selected explanatory variables, and alternative assumptions on the values of other independent variables. The 95 percent confidence intervals are also reported in these graphs, which

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8. In fact, since m_k is the slope of the probability curve, its value can be greater than 1. Such values, although correct from a computational point of view, have no meaningful interpretation from a probabilistic point of view.
9. It should be noted that special treatment is required to evaluate the change in predicted probability when the explanatory variable includes a quadratic term, such as the case of age and age squared. In this case the computation needs to include the change in both the linear and quadratic terms, which is the procedure followed in this analysis.
10. For dummy variables, $x_{min}=0$ and $x_{max}=1$, thus the change in probability from minimum to maximum value corresponds to the shift from absence to presence of the attribute represented by the dummy.
11. The variables for which we use α=0.1 and λ=0.9 are the following: area, capital, sales, and hired work.

provided further insight into the reliability of specific point estimates, particularly for extreme values of the explanatory variables.

Finally, we implement some simulations using the micro-data and mapping the results at the agricultural weighting area level.[12] While the previous computations assessed probability changes for the average operator (i.e. holding all explanatory variables that were not subject to change at their sample means), these micro-data simulations account for regional diversity in farming and economic conditions. The maps show the degree of variation across space that a policy induced change could have on the probability of off-farm work. For this part of the analysis we use only the result of the full-sample model. Hence, the probability changes are computed in a way analogous to that presented by equation (17), but in order to emphasize individual level computation this can be re-written as follows:

$$\Delta P_i \equiv \Pr(y_i = 1 \mid \mathbf{x}_i, \Delta x_i^k, \hat{\beta}) - \Pr(y_i = 1 \mid \mathbf{x}_i, \hat{\beta}) = \Phi(\mathbf{x}_i \hat{\beta} + \Delta x_i^k \hat{\beta}^k) - \Phi(\mathbf{x}_i \hat{\beta}) \qquad (18)$$

where ΔP_i stands for the probability change for the i^{th} operator due to a change (Δx) of the k^{th} explanatory variable, and holding all other variables ($\mathbf{x}_i$) at the original value observed for that individual.

We present the results of two simulations. It should be emphasized that, although the magnitude of changes are plausible, the choice of the variation was to some extent arbitrary and the simulations presented here have preeminently an exploratory and demonstrative purpose. The first simulation is intended to explore the effects of accelerated labour market dynamics on off-farm labour participation. We assume a uniform three percentage point increase in *local* and *regional* employment growth (1991-2001), and a uniform two percentage point decline in *local* and *regional* unemployment rate; it should be noted, however, that the inclusion of local and regional explanatory variables would allow more complex simulations that account for regional interactions.[13] The second simulation is intended to explore the effects of increasing farm size on off-farm labour participation. In this case, we assume a uniform increase of farm capital and farm sales of ten percent from the original value, for all census-farms across the country.[14] For both simulations, we compute the individual predicted probabilities of off-

12. Agricultural Weighting Areas (WA) are groupings of CCSs or Census Divisions, which are used for sampling and data reporting purposes by the Census of Agriculture. In 2001 there were 212 weighting areas. For details see Fontaine (1998).

13. In this simulation we assume a uniform change for all CCSs, hence both local and regional indicators vary by the same magnitude due to the way in which regional indicators are computed (see Section 3.3). For instance, a community that has original values of local employment change of 20 percent and regional employment change of 10 percent, would have simulation values of (20+3) = 23 percent and (10+3) = 13 percent, for local and regional indicators respectively. Similar computations would apply to unemployment rates. The specification of the model would allow the change in a local indicator only for a group of CCSs (for instance, urban CCSs). In that case, the change of the corresponding regional indicator would not be uniform and the result of the simulation would allow one to assess the impact of, say, urban changes on rural communities via the effect of regional changes.

14. For instance, if the original value of farm capital was $0.500 million, the simulation value was set to (0.500*1.1) = $0.550 million, and the corresponding squared term was adjusted accordingly. Similarly,

farm work after shocking the model and compare them with the predicted probabilities generated with the original data (base scenario). Individual probability changes are then averaged at the agricultural weighting area and mapped.

The following two sections present the results of discrete changes in explanatory variables, computed with the variety of techniques discussed above.

5.1 Discrete changes of selected variables, results

Tables 9, 10 and 11 show the level and change in predicted probabilities associated with selected values of the explanatory variables, for the full sample, smaller, and larger census-farms, respectively. The figures in bold correspond to coefficients that are statistically significant at the ten percent level or more. The following discussion focuses on these figures, with specific attention given to differences between operators of smaller and larger census-farms. Figures 1 to 6 present the graphical analysis conducted on selected variables. The results presented below reflect the findings outlined in the discussion of the coefficients estimates. The results are directly interpretable in terms of probability changes for substantively meaningful changes of the explanatory variables, and allow us to understand the effect of complex or interrelated changes of the explanatory variables.

Effect of individual characteristics on the probability of off-farm work. Age, gender and education have an important effect on the probability of being engaged in off-farm work, particularly for operators of smaller census-farms. Compared to the *average operator*[15] who has *predicted probability* of off-farm work of 0.41, the youngest operators are about 2 percent more likely to be engaged in off-farm work (Pr=0.43). The relationship between age and off-farm work, however, is not linear as indicated by Figure 1. With other variables being held at the average, this probability peaks at approximately 35 years of age (Pr= 0.59) and drops rapidly after 50 years of age to approximately 0 for the most senior operators in the sample. For the *average operator*, a change of 13 years of age (one standard deviation) from about 43 to 56 years of age is associated with a probability decline in off-farm work of 18 percent. Similar effects are noted for operators of smaller farms, while age is not a significant variable for operators of larger census-farms.

Compared to the *average male operator*, the *average female operator* is 6 percent less likely to be engaged in off-farm work, yet the sign of the gender differential is different for operators of smaller and larger census-farms. *Average female operators of smaller census-farms* have about 10 percent less probability of working off-farm compared to their male counterparts. In contrast, the *average female operators of larger census-farms* are almost 7 percent more likely to work off-farm compared to male operators of larger farms.

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if the original value of sales was $230 thousand , the simulation value was set to (230*1.1) = $253 thousand and the corresponding squared term was adjusted accordingly.

15. In the remainder of the paper we will use the term "average farm operator" to indicate the results of the full sample model for the operators of census-farms which represent average values for all the explanatory variables used in the model.

The probability of operating a census-farm and working off-farm is particularly high if the operator has a university degree. Compared to the average operator, the *average operator with a university degree* is almost 20 percent more likely to work off-farm (Pr=0.60). For operators of larger farms this probability differential reduces to about 9 percent. However, regardless of whether the full or sub-sample models are considered, attainment of more advanced education raises significantly the probability of off-farm work by operators. Moreover, the effect of education attainment is greater as one advances from high school, to university certificates, to university degrees.

Panels A and B of Figure 1 show the predicted probability of engaging in off-farm work for operators of smaller census-farms, given different combinations of gender, educational attainment and age, and holding other variables at their mean. For instance, a 25 year old female operator with less than a high school diploma has a 48 percent chance of being engaged in off-farm work (Panel A), compared to a 58 percent chance for a male operator of the same age and educational attainment (Panel A) and a 78 percent chance for a male operator of the same age with a university degree (Panel B).

Effect of family characteristics on the probability of off-farm work. Family characteristics have significant effects only for operators of smaller census-farms (and for the full sample model which is largely comprised of operators of smaller farms). In particular, compared to the *average operator*, individuals who have recently moved into the community are about 4 percent more likely to be involved in off-farm work (but this effect vanishes in the sub-sample estimates). The move may have been associated with the need for off-farm employment but it might also indicate lower adjustment costs relative to an individual who has remained in one location. For the *average operators of smaller census-farms* who report both unpaid housework and senior care, the probability of working off the farm is about 7 percent less than a similar operator not reporting any unpaid domestic labour.

Panels C and D (Figure 1) show the probability outcomes for operators of smaller census-farms and different combinations of age, gender, education and domestic work. In particular, the female operator of Panel C and male operator of Panel D represent the lower and upper predicted probability boundaries for various combinations of these individual and family characteristics. *Female operators of smaller census-farms reporting domestic work and less than high school education* have less than a 50 percent chance of being engaged in off-farm work, regardless of their age cohort (Panel C). This may be due to either additional household responsibilities that limit the amount of time available for off-farm employment or to gender discrimination by potential employers. This pattern is in contrast to the results for *male operators of smaller census-farms with a university degree and no sizable engagement in domestic work* who have a probability of off-farm engagement greater than 70 percent, for any age cohort between 20 to 50 years of age (Panel D). It should also be noted that gender differentials tend to decrease for higher working age cohorts if the educational attainment is lower (Panel C), but are more visibly persistent across working age cohorts for higher educational attainments (Panel D).

Effect of census-farm characteristics on the probability of off-farm work. As previously noted, the significance and direction of the effect of these variables is remarkably consistent across samples, although the magnitudes of the changes are to some extent different. The *average operator of a census-farm with more than one operator* is 3 to 4 percent more likely to work off-farm as compared to his/her counterpart who is a single operator on the farm. These figures are 6 to 8 percent for *average operators of a smaller census-farm*. Business arrangements also affect the likelihood of off-farm work; both *average operators of smaller and larger census farms that are corporations* are about 3 percent less likely to engage in off-farm activities, as compared to their counterparts who use partnerships or sole proprietorships as business arrangements.

However, some of the largest changes in probability of off-farm labour are observed for operators of different farm types. For the *average operator of a smaller census-farm, who is not operating a dairy farm,* the probability of off-farm engagement increases from 23 percent (for vegetable farm operators) to 37 percent (for grain and oilseeds farm operators). As compared to a similar operator who is a dairy farmer, in the case of larger census-farms this probability change is between 10 percent (vegetable farm) and 25 percent (poultry and egg farm), but it is still significant and positive for all types of farm relative to dairy farming. These differences are evident in Figure 2, which also combine alternative specifications of farm characteristics and farm size. The effect of being a dairy operator on the probability of off-farm work is striking; dairy operators are universally less likely to seek off-farm employment.

The effect of discrete changes of farm size is also revealing (Tables 9 to 11 and Figure 2). Changes between minimum and maximum values of farm size have generally a large impact on the probability of working off the farm, but for one standard deviation changes the effect on the probability is generally more contained. It should also be recalled that total sales was used as classification criteria to split the sample into smaller and larger holdings. Hence, it is not surprising that the magnitude of probability change is different between estimates, with the effect of these indicators being generally more important for operators of smaller census-farms.

For the *average operator of a smaller census-farm*, the total sales appear to be a critical factor in determining off-farm labour decisions. With growing sales, the probability of engaging in off-farm work drops sizably. The *average operator of a smaller census-farm*, with gross sales of $59,000, has a 47 percent chance of being involved in off-farm labour, while a comparable operator with gross sales of about $250,000 has a 26 percent chance, which means a 21 percent drop in the probability of engaging in off-farm work. For operators of smaller and larger census-farms, a one standard deviation change in capital size ($0.912 and $5.207 million, respectively) around the mean value ($0.588 and $2.747 million, respectively), is associated with an approximately 2 percent decline in the probability of working off-farm. For hired labour the same type of change is associated with approximately a 1 percent decline in the probability of off-farm work (Tables 10 and 11).

Figure 2 shows the predicted probability plots for plausible ranges of total farm capital, different types of farms (dairy and non-dairy), and number of operators (one and three). These figures, along with probability estimates for minimum and maximum value of x (Table 10 and 11), show that the quadratic terms of the farm size indicators have a sizable effect only for extreme values of farm size (and for very large ranges in confidence intervals). In other words, the curves are declining at a decreasing rate, but the "U" turn does not happen on the typical range of farm size, which suggest some caution in interpreting the effect of the quadratic terms.

Effect of local and regional characteristics on the probability of off-farm work. As anticipated in the discussion of coefficients, local and regional characteristics are more relevant for operators of smaller census-farms. The marginal effects for these employment variables are often large, as appears in Tables 6, 7, and 8. However, the effect of discrete changes are considerably more contained, which confirms that, for continuous variables, marginal effects do not always provide the best indication of probability change due to changes in the covariates. Moreover, the analysis of probability changes for "typical cases" that combine specific values of the explanatory variables adds considerable information to the analysis of single coefficients.

Operators who live in communities that experienced rapid employment growth are more likely to engage in off-farm work. The *average operator of a smaller census-farm* who lives in a community with the lowest employment dynamics is 6 percent less likely to work off-farm compared to a similar operator living in a community with the best employment dynamics. The probability differential between a locality with -8 percent employment change and a locality with 24 percent employment change (one standard deviation change) is less than 1 percent (Table 10). The incremental effect of this explanatory variable is similar for operators of smaller and larger census-farms as shown in Figure 3, Panel A. Yet, for the average operators of smaller census-farms, the effect of changing regional economic specialization and unemployment rates are larger: about a 2 percent change for a standard deviation change around the variable means.

To gain a better understanding on the effect of changing overall labour market conditions on the probability of off-farm work, we define a continuum of "typical cases". Figure 3, Panel B, shows the combined effect of various levels of employment growth, unemployment and economic specialization on the probability of off-farm work. The values of the indicators resemble a continuum of conditions from weak labour market to strong labour market. This continuum is clearly a simplification; nonetheless, it represents plausible ranges of the covariates and reflects the conditions observed in several communities across Canada.[16] Holding other variables constant, there is a clear effect of overall market conditions on the probability of off-farm employment. For the

16. For instance, weak labour market conditions resemble the conditions of some communities in Newfoundland (e.g. Division No. 1, Subd. W, St. Vincent's-St. Stephen's-Peter's River, Gaskiers, St. Mary's, Riverhead, Admirals Beach, St. Joseph's) or CCS 1001214 (Division No. 1, Subd. C, Branch, Point Lance, St. Bride's). The intermediate labour market conditions are found in various communities of P.E.I., Nova Scotia, and New Brunswick (e.g. Antigonish, Subd. B; Lot 16, Wellington; Maugerville; Rivière-Verte). Strong labour market conditions resemble the context of communities in Alberta (e.g. Rocky View No. 44) or in South-west Ontario (e.g. Vaughan).

average operator that is located in a community with a weaker labour market the probability of off-farm labour is below 40 percent. In contrast, the same *average operator located in a community with stronger labour market conditions* (employment growth from 1991 to 2001 of 50 percent, regional unemployment rate of 6.6 percent, and Herfindahl Index of 0.15) has slightly over a 50 percent chance of being engaged in off-farm work.

As pointed out in the discussion of signs and significance of the probit coefficients, the effect of local and regional employment variables is complex and difficult to detect. We explore these relationships by plotting predicted probabilities for alternative combinations of local/regional manufacturing and service employment (Figure 4 and 5, respectively). In the first panel (A) of each figure we make a simplifying assumption that employment shares are equally distributed and vary in fixed proportions. For instance, Figure 1, Panel A shows a range from 1.25 percent of local employment in each manufacturing sub-sector (equivalent to 5 percent total manufacturing employment) to 20 percent for each sub-sector (equivalent to 60 percent total manufacturing employment); same computations are used for regional employment in manufacturing.[17] In the second panel (B) of each figure, we plot the predicted probability for a plausible range of local employment shares and two alternative values of regional employment shares.

The main insight from Figures 4 and 5 is that both *local* manufacturing and services employment have a positive effect on the probability of off-farm work (once the effects of their sub-sectors is combined). However, an increasing *regional* employment share in manufacturing offsets the effect of local employment in manufacturing, while this is not the case for service employment. This is shown in Panel A in Figures 4 and 5, which show a flat line for manufacturing employment and a positively sloped line for service employment. The interpretation of this result (particularly for manufacturing) is not straightforward, and it might be related to specific regional conditions which are captured by the model coefficients. Panel B (Figures 4 and 5) which plot the predicted probability for alternative values of regional employment, reinforce this evidence. For manufacturing, the two lines are plotted for regional manufacturing employment of 20 and 30 percent, and the spread between the two show the regional effect. For example, the *average operator of a smaller census-farm* who lives in a community with 30 percent of the labour force in manufacturing has a probability of 0.46 of working off the farm and if the region has only 20 percent of the employment in manufacturing the probability declines to 0.38. In contrast, the two lines are almost overlapping for service employment (Figure 5, Panel B).

Effect of urbanization factors on the probability of off-farm work. The effect of urbanization indicators is particularly interesting and suggests that, once other factors are controlled for, off-farm employment options for census-farm operators are not necessarily determined by urban labour markets. On the contrary, these job opportunities appear to be more closely integrated with rural labour markets. For the *average operator located in the closest proximity of an urban center* the probability of working off the farm

17. In the computations of predicted probability with employment shares, we include the pertaining manufacturing and service employment variables which have no statistically significant effect.

is 39 percent (about 2 percent less than that of the *average operator*, located 55 km away from an urban center). Moving from 25 km to 75 km away from an urban center (one standard deviation change), the predicted probability for the average operator increases another 2 percentage points, and for a similar operator located in the most remote areas (about 350 km from an urban center) the chance of working off the farm is 9 percent higher than for the average Canadian census-farm operator. A similar pattern is observed for the *average operator of a smaller census-farm* (Figure 6, Panel A). Although the coefficient of the squared distance variable is significant, that is the relationship is not linear, Figure 6 shows that for prevailing ranges of distance to urban centers there is no evident quadratic effect.

Panel (B) of Figure 6 combines the effect of different indicators of urbanization: distance to CMA/CA, local and regional population density. Once again, the graph simplifies the possible combinations of these three indicators in order to represent a continuum of "typical case". The ranges of variation were defined on the basis of sample statistics and resemble the conditions observed in several communities of Canada. Overall, the negative effect of urbanization factors on the probability of off-farm employment of operators of smaller holdings is well evidenced by the analysis. Average census-farm operators located close to a CMA/CA (60 km) in a community and a region with a high population density (3,000 and 1,600 inhabitants/km^2, respectively) have a predicted probability value of about 0.3. This contrasts with a predicted probability of almost 0.5 for similar operators located 320 km from a CMA/CA in a low density community and region (720 and 550 inhabitants/km^2, respectively).

5.2 Spatial patterns of change, simulations with micro-data

The results of predicted probability estimation and simulations with the micro-data are presented in Map 1, 2, and 3. Map 1 displays the predicted probability of off-farm labour that was generated by the full sample model. Individual probabilities are averaged at the agricultural weighting area (WA) level, and these average values are mapped in seven percentiles. Dark purple areas indicate an average low probability of working off the farm (between 27 and 35 percent). Dark green areas indicate a high average probability of off-farm labour engagement (between 53 to 63 percent). The results of this map provide a benchmark for the two simulations. It should be noted that the spatial pattern of predicted probability generated by the model closely resembles the observed shares at the WA level, thus the model provides a good representation of the reality.

Map 2 shows the results of the first simulation that captures the effect of accelerated labour market dynamics through changes in employment growth rates and unemployment rates. The first evident result, for this as well as for the following simulation, is that changes in the average predicted probability are small. What appears interesting, however, is the clear spatial pattern that emerges from the maps. A uniform change in employment growth and unemployment rate would have larger effects (dark orange) in north-western Alberta and British Columbia, northern Saskatchewan, most of Manitoba, and some parts of south-western Ontario. In contrast, most of southern Saskatchewan, Quebec and southern Ontario, would experience more limited changes. Some of these

areas are already experiencing a relatively low unemployment rate, while in other areas it looks like employment dynamics may not be the main constraining factor in determining off-farm labour decisions.[18]

Map 3 shows the results of the second simulation which assess the effect of increasing farm size (capital and sales). Also, in this case, the changes in average predicted probability are found to be small and negative in sign as expected. The spatial distribution of this exogenous change, however, is quite different from the previous one. The largest reduction in off-farm work (dark purple areas) would occur in southern Alberta, coastal areas of British Columbia, south-western Ontario, and Prince Edward Island. In contrast with the previous simulation, there appears to be a greater difference in probability outcomes between south-western and south-eastern Quebec.

In summary, these micro-data simulations account for a variation in regional conditions. Although the changes in explanatory variables were set arbitrarily and with purely illustrative purpose, the results indicate that the impact of exogenous shocks on the probability of off-farm labour has a distinctive regional pattern which is determined by the initial condition of each area. In other words, policies that affect the determinants of off-farm labour engagement may have substantially different impacts in different farming and regional economic contexts.

6. Conclusions

In this paper we investigated the determinants of off-farm employment for operators associated with smaller and larger agricultural holdings. By combining micro-level and community level data, this analysis accounts for the characteristics of the individual, the agricultural holding, the community and the region. We estimate separate models for operators of smaller and larger agricultural holdings and pay specific attention to the effect of local and regional labour markets by including a set of spatially lagged variables that capture the characteristics of the region in which the farm is located. The results of this analysis, while confirming some findings of previous research regarding demographic and human capital indicators, provide further insights into the importance of different variables in determining the participation in off-farm labour markets by census-farm operators.

Overall, it appears that human capital and farm characteristics are significant and have similar effects for operators of both smaller and larger holdings. Among the individual-level covariates, educational attainment is a major determinant of the ability to be an operator of a census-farm and to participate in off-farm work. The type of farm must be amenable to off-farm work (i.e. dairy is not); at the same time increasing the number of operators within a farm increases the likelihood of off-farm employment by one of the operators. Hired work is a complement to farm labour by the operator as it allows the farmer to specialize and increase the marginal value of that labour.

18. At this regard, it should be recalled the non-linear nature of the model. The effect a discrete changes of an explanatory variable depends also on the level of all other explanatory variables.

In contrast, family characteristics as well as local and regional characteristics appear significantly more important for operators of smaller agricultural holdings. Local labour market characteristics do affect the likelihood of off-farm employment, but much more so for operators of smaller, compared to larger agricultural holdings. This finding does not appear to be at odds with the prevailing literature on smaller agricultural holdings, which emphasizes the combination of family, community and regional factors in determining family well-being. In particular, the importance of pluriactivity by members of families associated with agricultural holdings has been shown to be relevant in Canada. In addition to the process of exit from the agricultural sector, a partial adjustment of agricultural labour, through participation in off-farm work has become a pervasive strategy of census-farm operators and their families (Olfert and Stabler 1994). These trends have brought recognition to the fact that, in many rural areas, pluriactivity is likely to be an important strategy for maintaining livelihoods of farming families (OECD 1995). Moreover, it has been observed that part-time farming is a relatively unimportant facilitator of entry into commercial farming (Bollman and Steeves 1982); in other words off-farm employment is not part of a phase-in period to full-time farming. The implication is that to maximize family income, operators of agricultural holdings may have to face the choice of getting bigger or getting small (Bollman 1991). For operators of smaller holdings, the combination of family and local market conditions can play a critical role in determining the well-being of their family.

Another result that should be emphasized is the unexpected effect of proximity to urban areas. This result suggests that core urban regions are not the core labour market for the operators who are involved in off-farm labour – rather core urban areas appear to enhance the value of the operator's labour on the holding. The result suggests some degree of disjunction between the off-farm labour supply of operators of agricultural holdings and the urban economy. This finding has relevant implications for policies aiming to enhance the incomes of families associated with farming. There is evidence that a strong agricultural sector is neither necessary nor sufficient for high and growing household income in rural areas. Research findings from the US indicate that what matters is the linkage of farm factor markets, primarily labour, with the non-farm sector (Gardner 2000, and 2005; Fuller and Bollman 1992). Hence, off-farm labour represents one of the primary chains of transmission of wealth between the farm and non-farm sector. The results of this analysis, however, suggest that this chain of transmission from urban to census-farm operator households may be via the demand for farm products for sale in the urban labour markets.

With a growing share of employment opportunities concentrated in predominantly urbanised regions, the linkages between urban labour market and rural population remains vital for the economic sustainability of rural areas (Bollman and Biggs 1992; Schindegger and Krajasits 1997). However, the present analysis suggests that, for members of families associated with agricultural holdings involved in off-farm work, the main linkages are with the rural labour market itself. This finding parallels some research on commuting flows, which indicates that commuting flows are not always unidirectional and not even exclusively dominated by in-commuting to major urban centres (Green and Meyer 1997). Research conducted in Southern Ontario, for instance,

indicates a declining urban influence, as a pole of attraction, in face of an increasing rural "self-sufficiency" or a rural-to-rural pattern of interaction (Green and Meyer 1997). The nature of this rural-to-rural interaction should be further investigated with a specific focus on its relevance to off-farm labour opportunities for members of families associated with smaller agricultural holdings.

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Table 1 National statistics: selected variables for farm operators and farms, 2001

Variables	Total (units)	Number of operators of census-farms		As percent of total operators		As percent of variable total	
		No off-farm work	Some off-farm work	No off-farm work	Some off-farm work	No off-farm work	Some off-farm work
Farm operator							
Total number of operators	346,195	191,975	154,220	100.0	100.0	55.5	44.5
Sex - Female	91,180	49,565	41,615	25.8	27.0	54.4	45.6
Age - Under 35 years	39,915	17,610	22,310	9.2	14.5	44.1	55.9
Age - 35 to 54 years	185,575	86,145	99,430	44.9	64.5	46.4	53.6
Age - 55 years and over	120,705	88,225	32,485	46.0	21.1	73.1	26.9
Average age of operators	49.9	53.1	45.9	...	...	...	...
Farm type (NAICS classification)							
Cattle ranching and farming	125,795	76,265	49,530	39.7	32.1	60.6	39.4
Hog and pig farming	10,940	7,750	3,185	4.0	2.1	70.8	29.1
Poultry and egg production	7,240	4,255	2,980	2.2	1.9	58.8	41.2
Sheep and goat farming	6,235	2,395	3,840	1.2	2.5	38.4	61.6
Other animal production	33,665	13,340	20,325	6.9	13.2	39.6	60.4
Oilseed and grain farming	90,545	51,575	38,970	26.9	25.3	57.0	43.0
Vegetable and melon farming	7,315	4,745	2,575	2.5	1.7	64.9	35.2
Fruit and tree nut farming	11,050	5,610	5,445	2.9	3.5	50.8	49.3
Greenhouse, nursery and floriculture prod.	12,800	7,225	5,575	3.8	3.6	56.4	43.6
Other crop farming	40,605	18,825	21,785	9.8	14.1	46.4	53.7
Farms reporting total gross farm receipts							
Under $10,000	72,960	26,580	46,380	13.8	30.1	36.4	63.6
$10,000 to $49,999	101,685	45,145	56,535	23.5	36.7	44.4	55.6
$50,000 to $99,999	47,660	27,010	20,655	14.1	13.4	56.7	43.3
$100,000 to $249,999	68,205	48,080	20,125	25.0	13.0	70.5	29.5
$250,000 and over	55,685	45,160	10,530	23.5	6.8	81.1	18.9
Farms reporting total farm capital							
Under $100,000	15,680	6,270	9,410	3.3	6.1	40.0	60.0
$100,000 to $199,999	41,715	17,210	24,505	9.0	15.9	41.3	58.7
$200,000 to $499,999	119,055	54,545	64,510	28.4	41.8	45.8	54.2
$500,000 to $999,999	87,440	52,945	34,490	27.6	22.4	60.6	39.4
$1,000,000 and over	82,305	61,005	21,305	31.8	13.8	74.1	25.9
Farms reporting total farm area							
Under 10 acres (under 4 hectares)	17,795	7,890	9,905	4.1	6.4	44.3	55.7
10 to 69 acres (4 to 28 hectares)	47,035	19,850	27,190	10.3	17.6	42.2	57.8
70 to 239 acres (28 to 96 hectares)	98,385	48,390	49,990	25.2	32.4	49.2	50.8
240 to 559 acres (96 to 224 hectares)	74,455	43,930	30,530	22.9	19.8	59.0	41.0
560 to 1,599 acres (224 to 640 hectares)	69,720	44,050	25,665	22.9	16.6	63.2	36.8
1,600 acres and over (640 ha. and over)	38,805	27,870	10,930	14.5	7.1	71.8	28.2
Farm (units of measure)							
Average farm area (hectares)	273.6	...	...	....	...	...	...
Average farm receipts (dollars)	155,104	...	...	....	...	...	...
Average farm capital (dollars)	797,289	...	...	....	...	...	...
Total number of farms (units)	246,925	...	...	....	...	...	...

Source: Statistics Canada, Catalogue No. 95F0355XIE, and authors' elaboration on these data.

Table 2 Census-farms by selected Agriculture-Population linkage (AGPOP) variables, 2001

Variables	Total census-farms (units)	Percent of total census-farms
Farms classified as		
Sole proprietorship	143,500	58.1
Partnership with or without a written agreement	15,985	28.6
Family or Non-family corporation	27,940	12.9
Other	945	0.4
Farm type (SIC classification)		
Dairy	18,565	7.5
Cattle (beef)	70,350	28.5
Hog	7,505	3.0
Poultry and egg	4,890	2.0
Wheat	15,690	6.4
Grain and oilseed (excluding wheat)	53,595	21.7
Field crop (excluding grain and oilseed)	21,140	8.6
Fruit	7,750	3.1
Vegetable	3,315	1.3
Miscellaneous specialty	33,610	13.6
Livestock specialty	5,320	2.2
Other combination	5,190	2.1
Farms reporting household total income in 2000		
Under $25,000	42,000	17.0
$25,000 to $49,999	77,900	31.5
$50,000 to $74,999	60,195	24.4
$75,000 to $99,999	32,255	13.1
$100,000 and over	34,570	14.0
Farms reporting major source of household income in 2000		
Net farm income	54,440	22.0
Other employment income	137,415	55.7
Other sources of income	54,660	22.1
Zero income	410	0.2
Farms reporting - Net farm income or household's total income in 2000		
Either negative or zero	115,705	46.9
Less than 25% of household's total income	54,530	22.1
From 25% to 49% of household's total income	34,400	13.9
From 50% to 74% of household's total income	23,615	9.6
75% or more of household's total income	18,670	7.6
Farms reporting net farm income for the household		
Negative or zero net farm income	115,670	46.8
$1 to $9,999	49,675	20.1
$10,000 to $24,999	41,095	16.6
$25,000 to $49,999	26,080	10.6
$50,000 and over	14,400	5.8

Note: The unit counts are derived from Agriculture-Population Linkage 20% sample data, weighted up to represent the entire population. These figures will differ from corresponding figures appearing in the farm release tables, which were based on data collected from the entire population. See detailed notes for each variable at: http://www.statcan.ca/english/freepub/95F0303XIE/tables.htm

Source: Statistics Canada, Catalogue No. 95F0303XIE and authors' elaboration on these data.

Table 3 Description and computation of variables used in the model

Dimension/variable	Detailed description and computation
Off-farm work (dependent variable)	Dichotomous variable which takes value of 1 if the operator reported any work off the census-farm holding, regardless of the amount of time spent in off-farm work. In the Census of Agriculture 2001, "operators" were defined as those persons responsible for the day-to-day management decisions made in the operation of a census-farm or agricultural operation. Up to three operators could be reported per census-farm (Statistics Canada, 2001).
Individual characteristics	
Age	The age of the operator is entered as number of years (*Age*), as well as in its quadratic form as squared number of years of the operator (*Age*Age*) to allow for diminishing, or increasing, effects of an additional year of age.
Gender	*Gender* of the farm operator is entered as a dummy which takes the value of 1 if the operator is female, and 0 if male.
Education	A set of four dummy variables account for the effect of educational attainments: *Less than High School Diploma* takes the value 1 if the operator has not completed high school, and 0 otherwise (omitted category); *High School* takes the value 1 if the operator has a secondary school certificate or non-university degree; *University certificates* takes the value 1 if some university education below bachelor level, with or without diploma, is reported; *University degree* takes the value 1 if the operator has a bachelor degree or higher university degrees, and 0 otherwise.
Family characteristics	
Children	Dummy variable that takes the value of 1 if the presence of one or more children less than 15 years of age is reported in the family of the operator, and 0 otherwise.
Mobility	Dummy variable that takes the value 1 if the operator has changed address (dwelling) over the past five years, and takes value 0 is the operator has not changed address.
Domestic work	Three independent dummy variables capture the extent to which the operator is involved in domestic works. *Unpaid housework* takes the value 1 if the operator does more than 15 hours/week of unpaid housework, and the value 0 otherwise; *Unpaid childcare* takes the value of 1 if the operator is involved in more than 5 hours/week of child caring, and 0 otherwise; *Unpaid senior care* takes the value 1 if the operator is involved in more than 5 hours a week of care to seniors.
Farm characteristics	
Farm type	A set of twelve dummy variables describe the type of farming operation. This classification is generated by the Census of Agriculture (Statistics Canada 2002). Each census-farm is classified according to the predominant type of production. This is done by estimating the potential receipts from the inventories of crops and livestock reported on the census questionnaire and determining the product or group of products that make up the majority of the estimated receipts. The resulting twelve groups are the following (the dummy takes the value 1 if the farm belongs to the group and 0 otherwise): *Dairy* (omitted category), *Cattle (Beef)*, *Hog*, *Poultry and egg*, *Wheat*, *Grain and oilseed (except wheat specialty farms)*, *Field crop (except grain and oilseed specialty farms)*, *Fruit*, *Miscellaneous specialty*, *Livestock combination*, *Vegetable*, *Other combination*.

(continued)

Table 3 Description and computation of variables used in the model (continued)

Dimension/variable	Detailed description and computation
Number of census-farm operators	A set of three dummy variables indicates the number of operators involved in the census-farm (1 if the operators belong to that group, and 0 otherwise); the dummies are: *Single operator* (omitted category), *Two operators*, *Three operators*.
Business structure	Three types of farm organization are distinguished by using a set of dummy variables (1 if the operators belong to that group, and 0 otherwise): *Sole proprietorship* (omitted category); *Partnership* (with or without written agreement); *Corporation* (including family and non-family).
Farm size	Three indicators of farm size are used both in the linear and quadratic form to allow for diminishing, or increasing, effects of farm size. *Area* is the total land area of the farm in thousand hectares; *Capital* is the total farm capital in million dollars; *Sales* is the total gross farm receipts (excluding forest products) in thousand dollars.
Hired workers	This variable, in linear and quadratic form, is the total number of weeks of hired work, from both part-time and seasonal workers, used on the census-farm during the census year.
Local and regional characteristics	
Employment change	The *local employment change* is computed at the CCS level as percentage change of total experienced labour force between 1991 and 2001. *Regional employment change* is the corresponding spatial lag.
Specialization	The *local specialization* of the economy is measured by the Herfindahl Index applied to experienced labour force data; the index is the sum of the squares of the industry employment shares in 2001 (experienced labour force). Eleven major industry groups are used in the computation: agriculture, other primary sectors, four types of manufacturing industries (natural resource related (NRR), labour intensive (LI), scale based (SB), and product differentiated and science based (PDSB)), construction, and four types of service industries (distributive, business, consumer, and public services). *Regional specializiation* is the corresponding spatial lag.
Unemployment rate	The *local unemployment rate* of each CCS is computed as total unemployed individuals age 25 to 54 divided by unemployed and employed individuals age 25 to 54; *Regional unemployment rate* is the corresponding spatial lag.
Employment shares	Following Findeis et al. (1992), we focus on manufacturing and service industries. Eight industries types are used, four for manufacturing and four for services. Industries are classified according to NAICS 2001. We use a classification of industries based on Statistics Canada and previous research of the authors (details are available from the authors upon request). Manufacturing is divided into *Natural Resource Related (NRR)*, *Labour Intensive (LI)*, *Scale Based (SB)*, and *Product Differentiated and Science Based (PDSB)*; service industries are divided into *distributive*, *business*, *consumer* and *public services*. Each indictor is used at the *local* and *regional* level (spatial lag).
Distance to CMA/CA	This is the distance in kilometres between the CCS geographic centroid and the geographic centroid of the nearest Census Metropolitan Agglomeration (CMA) or Census Agglomeration (CA). The variable is used both in the linear and quadratic form (*Distance*Distance*).
Population density	*Local population density* is computed as total non-institutional population of a CCS in 2001 divided by the total land area of the CCS; *Regional population density* is the corresponding spatial lag.

Table 4 Sample descriptive statistics: full sample

Variable	No off-farm work		Off-farm work		Sample	
	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation
Individual characteristics						
Age	53.1	13.975	45.8	10.827	49.9	13.186
Gender	0.259	0.438	0.276	0.447	0.267	0.442
Education						
Less than high school	0.445	0.497	0.272	0.445	0.369	0.482
High school	0.421	0.494	0.520	0.500	0.465	0.499
University certificate	0.070	0.255	0.089	0.285	0.078	0.269
University degree	0.063	0.244	0.118	0.323	0.088	0.283
Family characteristics						
Presence of children	0.267	0.442	0.392	0.488	0.322	0.467
Mobility	0.119	0.324	0.195	0.396	0.153	0.360
Domestic work						
Unpaid housework	0.435	0.496	0.454	0.498	0.443	0.497
Unpaid childcare	0.272	0.445	0.374	0.484	0.317	0.465
Unpaid senior care	0.080	0.271	0.082	0.274	0.081	0.272
Farm characteristics						
Number of farm operators						
One operator	0.447	0.497	0.433	0.495	0.441	0.496
Two operators	0.451	0.498	0.506	0.500	0.475	0.499
Three operators	0.102	0.302	0.061	0.239	0.084	0.277
Farm Type						
Dairy	0.142	0.349	0.024	0.153	0.090	0.286
Cattle (Beef)	0.265	0.441	0.315	0.464	0.287	0.452
Hog	0.043	0.203	0.022	0.147	0.034	0.180
Poultry and egg	0.023	0.149	0.021	0.144	0.022	0.147
Wheat	0.057	0.232	0.052	0.221	0.055	0.227
Grain and oilseed (no wheat)	0.203	0.402	0.195	0.396	0.200	0.400
Field crop (no grain & oilseed)	0.075	0.263	0.094	0.291	0.083	0.276
Fruit	0.028	0.166	0.034	0.180	0.031	0.173
Miscellaneous specialty	0.104	0.306	0.183	0.387	0.139	0.346
Livestock combination	0.018	0.134	0.026	0.159	0.022	0.146
Vegetable	0.015	0.123	0.012	0.110	0.014	0.117
Other combination	0.026	0.159	0.022	0.148	0.024	0.154
Business Structure						
Sole proprietorship	0.446	0.497	0.514	0.500	0.476	0.499
Partnership	0.347	0.476	0.380	0.485	0.362	0.481
Corporation	0.207	0.405	0.105	0.307	0.162	0.368
Farm Size						
Total land area (1,000 ha)	0.411	1.269	0.219	0.629	0.326	1.040
Total capital ($1,000,000)	1.195	2.935	0.634	1.477	0.947	2.417
Total sales ($1,000)	339.227	2635.817	100.273	807.471	233.367	2042.687
Hired Workers						
Total weeks of hired work	64.051	384.565	18.086	176.637	43.7	311.0

(continued, see note on the following page)

Table 4 Sample descriptive statistics: full sample (continued)

Variable	No off-farm work		Off-farm work		Sample	
	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation
Local and regional characteristics						
Local employment growth	8.035	15.969	9.276	16.067	8.585	16.024
Regional employment growth	6.663	8.859	7.079	8.955	6.847	8.904
Local specialization	0.188	0.071	0.185	0.062	0.186	0.067
Regional specialization	0.199	0.045	0.200	0.042	0.200	0.044
Local unemployment	0.052	0.043	0.053	0.043	0.053	0.043
Regional unemployment	0.054	0.032	0.054	0.031	0.054	0.031
Employment Structure						
Local Manuf. NRR	0.039	0.035	0.036	0.031	0.037	0.033
Regional Manuf. NRR	0.037	0.021	0.034	0.019	0.035	0.020
Local Manuf. LI	0.022	0.033	0.018	0.029	0.020	0.031
Regional Manuf. LI	0.022	0.025	0.018	0.020	0.020	0.023
Local Manuf. SB	0.038	0.040	0.039	0.040	0.038	0.040
Regional Manuf. SB	0.038	0.028	0.036	0.027	0.037	0.028
Local Manuf. PDSB	0.023	0.024	0.021	0.022	0.022	0.023
Regional Manuf. PDSB	0.023	0.016	0.021	0.015	0.022	0.015
Local distr. Services	0.110	0.036	0.111	0.034	0.110	0.035
Regional distr. Services	0.109	0.015	0.109	0.014	0.109	0.015
Local Business Serv.	0.069	0.035	0.071	0.034	0.070	0.035
Regional Business Serv.	0.071	0.022	0.072	0.022	0.071	0.022
Local Consumer Serv.	0.202	0.057	0.208	0.056	0.205	0.057
Regional Consumer Serv.	0.204	0.037	0.209	0.038	0.206	0.037
Local Public Services	0.207	0.066	0.214	0.064	0.210	0.065
Regional Public Services	0.208	0.030	0.212	0.030	0.210	0.030
Urbanization						
Distance to CMA/CA	53.4	45.0	58.2	50.6	55.6	47.6
Local population density	48.1	164.5	43.7	147.7	46.2	157.3
Regional population density	99.1	164.7	100.2	161.5	99.6	163.3
Number of operators in the sample	38,876	...	30,921	...	69,797	...

Note: these data refer to operators and operator families in private dwellings (residents of collective dwellings are excluded). The data are unweighted to be consistent with the procedure adopted in the econometric model. A tabulation of descriptive characteristics with weighted data shows the same pattern, as portrayed in Tables 1 and 2. The averages for local and regional characteristics should be interpreted as the average local and regional condition experienced by the operators in the sample. See Table 3 for variable definitions and unit of measures.
Source: Authors' computations based on Census of Agriculture 2001 and Census of Population 2001 data.

Table 5 Sample descriptive statistics: operators of smaller and larger census-farms

Variable	Operators of smaller census-farms (sales < $250,000)				Operators of larger census-farms (sales ≥ $250,000)			
	No off-farm work		Off-farm work		No off-farm work		Off-farm work	
	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation
Individual characteristics								
Age	54.975	14.173	45.917	10.836	47.187	11.472	44.259	10.593
Gender	0.274	0.446	0.274	0.446	0.211	0.408	0.299	0.458
Less than high school	0.482	0.500	0.273	0.446	0.330	0.470	0.262	0.440
High school	0.396	0.489	0.521	0.500	0.503	0.500	0.508	0.500
University certificate	0.064	0.246	0.088	0.283	0.087	0.283	0.107	0.309
University degree	0.058	0.234	0.118	0.322	0.080	0.271	0.122	0.328
Family characteristics								
Presence of children	0.227	0.419	0.386	0.487	0.393	0.488	0.459	0.498
Mobility	0.110	0.313	0.198	0.398	0.147	0.354	0.162	0.369
Unpaid housework	0.474	0.499	0.461	0.498	0.311	0.463	0.371	0.483
Unpaid childcare	0.251	0.433	0.372	0.483	0.339	0.473	0.401	0.490
Unpaid senior care	0.086	0.280	0.083	0.276	0.062	0.240	0.065	0.246
Farm characteristics								
One operator	0.487	0.500	0.445	0.497	0.323	0.468	0.281	0.450
Two operators	0.449	0.497	0.505	0.500	0.458	0.498	0.524	0.500
Three operators	0.065	0.246	0.051	0.219	0.219	0.414	0.195	0.397
Dairy	0.107	0.309	0.018	0.133	0.254	0.435	0.102	0.302
Cattle (Beef)	0.303	0.460	0.324	0.468	0.144	0.351	0.192	0.394
Hog	0.022	0.145	0.016	0.127	0.110	0.313	0.095	0.294
Poultry and egg	0.009	0.094	0.015	0.122	0.066	0.249	0.100	0.300
Wheat	0.067	0.250	0.053	0.224	0.025	0.156	0.036	0.186
Grain and oilseed (exc. wheat)	0.200	0.400	0.186	0.389	0.212	0.409	0.318	0.466
Field crop (exc. grain and oilseed)	0.083	0.275	0.098	0.297	0.050	0.217	0.041	0.199
Fruit	0.032	0.176	0.035	0.184	0.017	0.129	0.017	0.127
Miscellaneous specialty	0.116	0.320	0.193	0.395	0.068	0.252	0.056	0.229
Livestock combination	0.020	0.139	0.027	0.162	0.014	0.116	0.011	0.105
Vegetable	0.013	0.114	0.012	0.109	0.022	0.148	0.016	0.124
Other combination	0.028	0.166	0.023	0.149	0.018	0.131	0.017	0.129
Sole proprietorship	0.531	0.499	0.537	0.499	0.180	0.384	0.220	0.415
Partnership	0.353	0.478	0.382	0.486	0.328	0.470	0.357	0.479
Corporation	0.117	0.321	0.081	0.272	0.491	0.500	0.423	0.494
Total land area (1,000 ha)	0.319	1.028	0.174	0.439	0.701	1.804	0.799	1.623
Total capital ($1,000,000)	0.683	1.085	0.490	0.679	2.815	5.355	2.467	4.535
Total sales ($1,000)	75.207	69.783	43.153	53.313	1173.786	5289.474	830.942	2895.478
Total weeks of hired work	14.623	32.817	7.526	23.124	220.291	761.497	153.166	635.582

(continued. see note on the following page)

Table 5 Sample descriptive statistics: operators of smaller and larger census-farms (continued)

Variable	Operators of smaller census-farms (sales < $250,000)				Operators of larger census-farms (sales ≥ $250,000)			
	No off-farm work		Off-farm work		No off-farm work		Off-farm work	
	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation	Mean (or ratio)	Standard deviation
Local and regional characteristics								
Local employment growth	7.527	16.108	9.304	16.061	9.640	15.412	8.907	16.132
Regional employment growth	6.309	9.034	7.124	8.958	7.785	8.184	6.499	8.892
Local specialization	0.191	0.074	0.185	0.062	0.177	0.060	0.184	0.064
Regional specialization	0.202	0.046	0.201	0.042	0.190	0.042	0.199	0.045
Local unemployment	0.053	0.044	0.054	0.044	0.048	0.038	0.044	0.034
Regional unemployment	0.055	0.032	0.055	0.031	0.054	0.031	0.050	0.027
Employment structure								
Local Manuf. NRR	0.037	0.034	0.035	0.031	0.046	0.036	0.041	0.035
Regional Manuf. NRR	0.035	0.021	0.034	0.019	0.042	0.022	0.037	0.021
Local Manuf. LI	0.020	0.033	0.018	0.029	0.027	0.035	0.021	0.029
Regional Manuf. LI	0.020	0.024	0.017	0.020	0.027	0.026	0.021	0.022
Local Manuf. SB	0.038	0.040	0.039	0.040	0.039	0.037	0.036	0.037
Regional Manuf. SB	0.037	0.028	0.036	0.027	0.041	0.028	0.036	0.029
Local Manuf. PDSB	0.022	0.024	0.021	0.022	0.027	0.025	0.023	0.023
Regional Manuf. PDSB	0.022	0.015	0.021	0.015	0.027	0.017	0.024	0.016
Local distr. Services	0.109	0.036	0.111	0.034	0.114	0.035	0.113	0.034
Regional distr. Services	0.109	0.015	0.109	0.014	0.111	0.015	0.110	0.015
Local Business Serv.	0.069	0.035	0.072	0.034	0.072	0.034	0.068	0.033
Regional Business Serv.	0.070	0.022	0.072	0.022	0.073	0.023	0.070	0.022
Local Consumer Serv.	0.202	0.059	0.209	0.056	0.201	0.053	0.198	0.053
Regional Consumer Serv.	0.204	0.038	0.209	0.038	0.204	0.032	0.201	0.034
Local Public Services	0.209	0.067	0.215	0.065	0.201	0.063	0.203	0.060
Regional Public Services	0.209	0.030	0.212	0.030	0.205	0.030	0.205	0.028
Urbanization								
Distance to CMA/CA	56.5	46.7	58.5	50.9	43.7	37.3	54.2	46.6
Local population density	43.7	154.9	43.1	144.9	62.1	191.0	50.1	178.8
Regional population density	94.0	159.1	100.3	161.6	115.4	180.3	98.5	160.2
Number of operators in the sample	29,533	...	28,679	...	9,343	...	2,242	...

Note: these data refer to operators and operator families in private dwellings (residents of collective dwellings are excluded). The data are unweighted to be consistent with the procedure adopted in the econometric model. A tabulation of descriptive characteristics with weighted data shows the same pattern, as portrayed in Tables 1 and 2. The averages for local and regional characteristics should be interpreted as the average local and regional condition experienced by the operators in the sample. See Table 3 for variable definitions and unit of measures.
Source: Authors' computations based on Census of Agriculture 2001 and Census of Population 2001 data.

Table 6 Results of probit model and marginal effects: full sample

Variable	Coefficient		Marginal effect			
	β	r.s.e.	$d\Phi/dx$	r.s.e.	z	P>|z|
Intercept	-2.255	0.172	...	...	-13.10	0.00
Individual characteristics						
Age	0.074	0.003	0.029	0.001	22.30	0.00
Age*Age $(10)^{-2}$	-0.108	0.003	0.042	0.001	-31.53	0.00
Gender	-0.161	0.014	-0.062	0.005	-11.50	0.00
Education						
High school	0.247	0.012	0.096	0.005	20.30	0.00
University certificate	0.263	0.021	0.104	0.008	12.73	0.00
University degree	0.526	0.020	0.207	0.008	26.07	0.00
Family characteristics						
Children	-0.054	0.015	-0.021	0.006	-3.53	0.00
Mobility	0.103	0.015	0.040	0.006	6.78	0.00
Domestic work						
Unpaid housework	-0.007	0.012	-0.003	0.005	-0.56	0.58
Unpaid childcare	0.004	0.015	0.001	0.006	0.25	0.80
Unpaid senior care	-0.068	0.019	-0.026	0.007	-3.54	0.00
Number of farm operators						
Two operators	0.097	0.013	0.038	0.005	7.22	0.00
Three operators	0.074	0.024	0.029	0.010	3.03	0.00
Farm characteristics						
Farm Type						
Cattle (Beef)	1.238	0.026	0.464	0.009	46.97	0.00
Hog	0.676	0.038	0.264	0.014	18.01	0.00
Poultry and egg	1.019	0.043	0.377	0.013	23.82	0.00
Wheat	1.245	0.035	0.444	0.009	35.91	0.00
Grain and oilseed	1.192	0.028	0.445	0.009	43.05	0.00
Field crop	1.276	0.030	0.457	0.008	42.17	0.00
Fruit	1.148	0.038	0.415	0.010	30.12	0.00
Miscellaneous specialty	1.293	0.028	0.470	0.008	46.59	0.00
Livestock combination	1.177	0.041	0.421	0.011	28.77	0.00
Vegetable	0.919	0.051	0.346	0.016	18.20	0.00
Other combination	1.066	0.042	0.391	0.012	25.44	0.00
Business Structure						
Partnership	-0.044	0.013	-0.017	0.005	-3.36	0.00
Corporation	-0.267	0.020	-0.101	0.007	-13.56	0.00
Farm Size						
Area	-0.210	0.031	-0.082	0.012	-6.81	0.00
Area*Area	0.006	0.002	0.002	0.001	3.66	0.00
Capital	-0.130	0.013	-0.050	0.005	-10.02	0.00
Capital*Capital $(10)^{-2}$	0.134	0.014	0.052	0.005	9.58	0.00
Sales $(10)^{-3}$	-0.040	0.023	-0.016	0.009	-1.77	0.08
Sales*Sales $(10)^{-5}$	0.011	0.009	0.004	0.003	1.23	0.22
Hired Workers						
Weeks $(10)^{-2}$	-0.059	0.013	-0.023	0.005	-4.70	0.00
Weeks*Weeks $(10)^{-6}$	0.044	0.010	0.017	0.004	4.23	0.00

(continued, see note on the following page)

Table 6 Results of probit model and marginal effects: full sample (continued)

Variable	Coefficient		Marginal effect			
	β	r.s.e.	dΦ/dx	r.s.e.	z	P>|z|
Local and regional characteristics						
Local employment growth $(10)^{-2}$	0.001	0.000	0.000	0.000	2.28	0.02
Regional employment growth $(10)^{-2}$	-0.001	0.001	0.000	0.001	-0.76	0.45
Local specialization	-0.125	0.134	-0.048	0.052	-0.93	0.35
Regional specialization	-0.638	0.341	-0.248	0.133	-1.87	0.06
Local unemployment	-0.146	0.185	-0.057	0.072	-0.79	0.43
Regional unemployment	-0.847	0.314	-0.330	0.122	-2.69	0.01
Employment structure						
Local manuf. NRR	0.312	0.235	0.121	0.092	1.33	0.19
Regional manuf. NRR	0.514	0.601	0.200	0.234	0.85	0.39
Local manuf. LI	1.527	0.319	0.594	0.124	4.78	0.00
Regional manuf. LI	-4.149	0.619	-1.614	0.241	-6.70	0.00
Local manuf. SB	1.009	0.206	0.393	0.080	4.89	0.00
Regional manuf. SB	0.508	0.415	0.198	0.162	1.22	0.22
Local manuf. PDSB	0.269	0.343	0.105	0.133	0.79	0.43
Regional manuf. PDSB	-3.973	0.858	-1.546	0.334	-4.63	0.00
Local distr. services	0.588	0.200	0.229	0.078	2.94	0.00
Regional distr. services	-1.070	0.596	-0.416	0.232	-1.79	0.07
Local business services	0.465	0.247	0.181	0.096	1.88	0.06
Regional business services	2.871	0.776	1.117	0.302	3.70	0.00
Local consumer services	0.554	0.126	0.216	0.049	4.40	0.00
Regional consumer services	0.038	0.334	0.015	0.130	0.11	0.91
Local public services	0.370	0.110	0.144	0.043	3.38	0.00
Regional public services	0.212	0.279	0.082	0.109	0.76	0.45
Urbanization						
Distance to CMA/CA $(10)^{-2}$	0.108	0.030	0.042	0.012	3.56	0.00
Distance*Distance $(10)^{-4}$	-0.010	0.011	-0.004	0.004	-0.90	0.37
Local population density $(10)^{-2}$	-0.011	0.004	-0.004	0.002	-2.48	0.01
Regional population density $(10)^{-2}$	-0.015	0.007	-0.006	0.003	-2.12	0.03
X^2 H_0 : all $\beta_{local} = 0$, (df=12)	146.19	$p<0.01$	...	...	...	...
X^2 H_0 : all $\beta_{regional} = 0$, (df=12)	143.86	$p<0.01$	...	...	...	...
X^2 H_0 : all β_{local} and $\beta_{regional} = 0$, (df=24)	439.74	$p<0.01$	...	...	...	...
Model statistics						
Log-likelihood – Full model	-38916.9	...	...	...	...	...
Log likelihood – Intercept model	-47925.3	...	...	...	...	...
Likelihood Ratio Index (McFadden's R^2)	0.188	...	...	...	...	...
McKelvey and Zavoina's R^2	0.382	...	...	...	...	...
Cragg and Uhler's R^2	0.305	...	...	...	...	...
Number of observations (operators)	69,797	...	...	...	...	...

Note: "r.s.e." indicates White robust standard error. For dichotomous variables the marginal effect represents the probability change due to a shift from value of 0 to value of 1 (i.e. absence to presence of the attribute). Some of the coefficients, r.s.e. and marginal effects are scaled for convenience of display; these values are denoted by the scaling factor: $(10)^{-n}$. See Table 3 for variable definitions and unit of measures.
Source: Authors' computations based on Census of Agriculture 2001 and Census of Population 2001 data.

Table 7 Results of probit model and marginal effects: operators of smaller census-farms (sales< $250,000)

Variable	Coefficient		Marginal effect			
	β	r.s.e.	dΦ/dx	r.s.e.	z	P>|z|
Intercept	-1.026	0.193	...	...	-5.33	0.00
Individual characteristics						
Age	0.091	0.004	0.036	0.002	23.75	0.00
Age*Age $(10)^{-2}$	-0.130	0.004	-0.052	0.002	-32.75	0.00
Gender	-0.253	0.015	-0.100	0.006	-16.34	0.00
Education						
High school	0.285	0.013	0.113	0.005	21.27	0.00
University certificates	0.321	0.023	0.127	0.009	13.82	0.00
University degree	0.563	0.023	0.219	0.008	24.88	0.00
Family characteristics						
Children	0.005	0.017	0.002	0.007	0.28	0.78
Mobility	0.020	0.017	0.008	0.007	1.17	0.24
Domestic work						
Unpaid housework	-0.085	0.013	-0.034	0.005	-6.59	0.00
Unpaid childcare	-0.007	0.016	-0.003	0.007	-0.45	0.65
Unpaid senior care	-0.096	0.021	-0.038	0.008	-4.52	0.00
Number of farm operators						
Two operators	0.159	0.015	0.063	0.006	10.74	0.00
Three operators	0.211	0.029	0.084	0.012	7.16	0.00
Farm characteristics						
Farm Type						
Cattle (Beef)	0.897	0.033	0.345	0.012	26.84	0.00
Hog	0.706	0.050	0.266	0.017	14.04	0.00
Poultry and egg	0.965	0.062	0.344	0.017	15.50	0.00
Wheat	0.931	0.041	0.340	0.012	22.56	0.00
Grain and oilseed	0.983	0.034	0.368	0.011	28.85	0.00
Field crop	0.848	0.038	0.317	0.012	22.56	0.00
Fruit	0.769	0.045	0.287	0.014	17.12	0.00
Miscellaneous specialty	0.845	0.035	0.320	0.012	24.37	0.00
Livestock combination	0.779	0.048	0.290	0.015	16.07	0.00
Vegetable	0.588	0.061	0.226	0.021	9.64	0.00
Other combination	0.635	0.049	0.243	0.017	12.94	0.00
Business Structure						
Partnership	0.012	0.015	0.005	0.006	0.83	0.41
Corporation	-0.083	0.022	-0.033	0.009	-3.72	0.00
Farm Size						
Area	-0.248	0.029	-0.099	0.012	-8.50	0.00
Area*Area	0.008	0.002	0.003	0.001	5.09	0.00
Capital	-0.052	0.014	-0.021	0.006	-3.67	0.00
Capital*Capital $(10)^{-2}$	0.085	0.028	0.034	0.011	3.03	0.00
Sales $(10)^{-2}$	-1.043	0.035	-0.415	0.014	-30.04	0.00
Sales*Sales $(10)^{-3}$	0.026	0.002	0.010	0.001	16.92	0.00
Hired Workers						
Weeks $(10)^{-2}$	-0.117	0.033	-0.046	0.013	-3.50	0.00
Weeks*Weeks $(10)^{-4}$	0.025	0.009	0.010	0.004	2.76	0.01

(continued, see note on the following page)

Table 7 Results of probit model and marginal effects: operators of smaller census-farms (sales <$250,000) (continued)

Variable	Coefficient		Marginal effect			
	β	r.s.e.	dΦ/dx	r.s.e.	z	P>|z|
Local and regional characteristics						
Local employment growth $(10)^{-2}$	0.087	0.053	0.035	0.021	1.64	0.10
Regional employment growth $(10)^{-2}$	-0.063	0.151	-0.025	0.060	-0.42	0.67
Local specialization	-0.213	0.147	-0.085	0.059	-1.44	0.15
Regional specialization	-1.304	0.379	-0.519	0.151	-3.44	0.00
Local unemployment	-0.137	0.203	-0.054	0.081	-0.67	0.50
Regional unemployment	-1.384	0.353	-0.551	0.140	-3.92	0.00
Employment Structure						
Local manuf. NRR	0.127	0.261	0.050	0.104	0.49	0.63
Regional manuf. NRR	1.140	0.679	0.454	0.270	1.68	0.09
Local manuf. LI	1.192	0.364	0.474	0.145	3.28	0.00
Regional manuf. LI	-5.368	0.695	-2.136	0.277	-7.72	0.00
Local manuf. SB	0.479	0.227	0.191	0.090	2.11	0.04
Regional manuf. SB	-0.016	0.467	-0.006	0.186	-0.03	0.97
Local manuf. PDSB	0.350	0.387	0.139	0.154	0.90	0.37
Regional manuf. PDSB	-3.361	0.967	-1.338	0.385	-3.47	0.00
Local distr. services	0.409	0.221	0.163	0.088	1.85	0.06
Regional distr. services	-1.251	0.668	-0.498	0.266	-1.87	0.06
Local business services	0.262	0.272	0.104	0.108	0.97	0.33
Regional business services	2.350	0.869	0.935	0.346	2.70	0.01
Local consumer services	0.326	0.139	0.130	0.055	2.35	0.02
Regional consumer services	-1.265	0.370	-0.503	0.147	-3.42	0.00
Local public services	0.212	0.121	0.084	0.048	1.74	0.08
Regional public services	-0.313	0.309	-0.124	0.123	-1.01	0.31
Urbanization						
Distance to CMA/CA $(10)^{-2}$	0.061	0.033	0.024	0.013	1.84	0.07
Distance*Distance $(10)^{-4}$	0.001	0.013	0.000	0.005	0.05	0.96
Local population density $(10)^{-2}$	-0.008	0.005	-0.003	0.002	-1.55	0.12
Regional population density $(10)^{-2}$	-0.014	0.007	-0.005	0.003	-1.83	0.07
X^2 H_0 :all $\beta_{local} = 0$, (df=12)	60.86	$p<0.01$	...	...	...	...
X^2 H_0 : all $\beta_{regional} = 0$, (df=12)	132.64	$p<0.01$	...	...	...	...
X^2 H_0 : all β_{local} and $\beta_{regional} = 0$, (df=24)	257.83	$p<0.01$	...	...	...	...
Model statistics						
Log-likelihood – Full model	-31216.9	...	....	...	...	...
Log likelihood – Intercept model	-40343.2	...	...	...	...	...
Likelihood Ratio Index (McFadden's R^2)	0.226	...	...	...	...	...
McKelvey and Zavoina's R^2	0.424	...	...	...	...	...
Cragg and Uhler's R^2	0.359	...	...	...	...	...
Number of observations (operators)	58,212	...	...	...	...	...

Note: "r.s.e." indicates White robust standard error. For dichotomous variables the marginal effect represents the probability change due to a shift from value of 0 to value of 1 (i.e. absence to presence of the attribute). Some of the coefficients, r.s.e. and marginal effects are scaled for convenience of display; these values are denoted by the scaling factor: $(10)^{-n}$. See Table 3 for variable definitions and unit of measures.

Source: Authors' computations based on Census of Agriculture 2001 and Census of Population 2001 data.

Table 8 Results of probit model and marginal effects: operators of larger census-farms (sales ≥ $250,000)

Variable	Coefficient		Marginal effect			
	β	r.s.e.	dΦ/dx	r.s.e.	z	P>|z|
Intercept	-0.850	0.483	...	...	-1.76	0.08
Individual characteristics						
Age	-0.002	0.008	0.000	0.002	-0.18	0.85
Age*Age $(10)^{-2}$	-0.014	0.009	-0.004	0.002	-1.60	0.11
Gender	0.244	0.040	0.067	0.012	6.05	0.00
Education						
High school	0.073	0.034	0.019	0.009	2.17	0.03
University certificates	0.118	0.052	0.032	0.015	2.26	0.02
University degree	0.303	0.052	0.087	0.016	5.81	0.00
Family characteristics						
Children	-0.016	0.038	-0.004	0.010	-0.42	0.67
Mobility	0.024	0.040	0.006	0.010	0.60	0.55
Domestic work						
Unpaid housework	0.004	0.036	0.001	0.009	0.12	0.90
Unpaid childcare	-0.002	0.037	-0.001	0.009	-0.06	0.95
Unpaid senior care	-0.055	0.059	-0.014	0.014	-0.94	0.35
Number of farm operators						
Two operators	0.108	0.038	0.028	0.010	2.83	0.01
Three operators	0.126	0.046	0.033	0.013	2.72	0.01
Farm characteristics						
Farm Type						
Cattle (Beef)	0.693	0.057	0.215	0.020	12.10	0.00
Hog	0.444	0.058	0.132	0.019	7.65	0.00
Poultry and egg	0.777	0.062	0.254	0.023	12.43	0.00
Wheat	0.708	0.093	0.233	0.035	7.62	0.00
Grain and oilseed	0.745	0.053	0.224	0.018	14.12	0.00
Field crop	0.455	0.077	0.139	0.027	5.93	0.00
Fruit	0.579	0.116	0.185	0.043	4.99	0.00
Miscellaneous specialty	0.407	0.074	0.121	0.025	5.51	0.00
Livestock combination	0.381	0.128	0.115	0.043	2.98	0.00
Vegetable	0.353	0.109	0.105	0.036	3.22	0.00
Other combination	0.600	0.111	0.193	0.041	5.42	0.00
Business Structure						
Partnership	-0.050	0.043	-0.013	0.011	-1.18	0.24
Corporation	-0.120	0.041	-0.031	0.011	-2.93	0.00
Farm Size						
Area	-0.014	0.016	-0.003	0.004	-0.86	0.39
Area*Area $(10)^{-2}$	0.027	0.034	0.007	0.009	0.80	0.43
Capital	-0.019	0.008	-0.005	0.002	-2.45	0.01
Capital*Capital $(10)^{-2}$	0.022	0.009	0.006	0.002	2.39	0.02
Sales $(10)^{-4}$	-0.106	0.094	-0.027	0.024	-1.13	0.26
Sales*Sales $(10)^{-9}$	0.020	0.034	0.005	0.009	0.58	0.56
Hired Workers						
Weeks $(10)^{-2}$	-0.007	0.005	-0.002	0.001	-1.32	0.19
Weeks*Weeks $(10)^{-7}$	0.070	0.033	0.018	0.009	2.10	0.04

(continued, see note on the following page)

Table 8 Results of probit model and marginal effects: operators of larger census-farms (sales ≥ $250,000) (continued)

Variable	Coefficient		Marginal effect			
	β	r.s.e.	dΦ/dx	r.s.e.	z	P>|z|
Local and regional characteristics						
Local employment growth $(10)^{-2}$	0.251	0.126	0.065	0.033	1.99	0.05
Regional employment growth $(10)^{-2}$	-0.138	0.375	-0.036	0.097	-0.37	0.71
Local specialization	-0.381	0.397	-0.098	0.102	-0.96	0.34
Regional specialization	-0.206	0.970	-0.053	0.250	-0.21	0.83
Local unemployment	-1.664	0.574	-0.429	0.148	-2.90	0.00
Regional unemployment	1.412	0.830	0.364	0.214	1.70	0.09
Employment Structure						
Local manuf. NRR	0.557	0.607	0.144	0.156	0.92	0.36
Regional manuf. NRR	-1.454	1.497	-0.375	0.386	-0.97	0.33
Local manuf. LI	0.773	0.746	0.199	0.192	1.04	0.30
Regional manuf. LI	-3.503	1.494	-0.903	0.385	-2.35	0.02
Local manuf. SB	0.503	0.602	0.130	0.155	0.84	0.40
Regional manuf. SB	0.765	1.077	0.197	0.278	0.71	0.48
Local manuf. PDSB	-1.448	0.853	-0.373	0.220	-1.70	0.09
Regional manuf. PDSB	1.122	2.157	0.289	0.556	0.52	0.60
Local distr. services	0.363	0.525	0.094	0.135	0.69	0.49
Regional distr. services	-1.840	1.600	-0.474	0.412	-1.15	0.25
Local business services	-2.044	0.714	-0.527	0.184	-2.86	0.00
Regional business services	2.722	2.054	0.701	0.529	1.32	0.19
Local consumer services	0.280	0.357	0.072	0.092	0.78	0.43
Regional consumer services	-0.112	0.977	-0.029	0.252	-0.11	0.91
Local public services	0.268	0.310	0.069	0.080	0.86	0.39
Regional public services	-0.431	0.783	-0.111	0.202	-0.55	0.58
Urbanization						
Distance to CMA/CA $(10)^{-2}$	0.112	0.091	0.029	0.023	1.23	0.22
Distance*Distance $(10)^{-4}$	0.034	0.036	0.009	0.009	0.93	0.35
Local population density $(10)^{-2}$	0.011	0.010	0.003	0.003	1.04	0.30
Regional population density $(10)^{-2}$	-0.012	0.019	-0.003	0.005	-0.62	0.53
X^2 H_0 : all $\beta_{local} = 0$, $(df=12)$	25.89	p=0.01	...	...	...	...
X^2 H_0 : all $\beta_{regional} = 0$, $(df=12)$	15.85	p=0.20	...	...	...	...
X^2 H_0 : all β_{local} and $\beta_{regional} = 0$, $(df=24)$	44.79	p=0.01	...	...	...	...
Model statistics						
Log-likelihood – Full model	-5285.5	...	...	...	...	...
Log likelihood – Intercept model	-5691.7	...	...	...	...	...
Likelihood Ratio Index (McFadden's R^2)	0.071	...	...	...	...	...
McKelvey and Zavoina's R^2	0.143	...	...	...	...	...
Cragg and Uhler's R^2	0.108	...	...	...	...	...
Number of observations (operators)	11,585	...	...	...	...	...

Note: "r.s.e." indicates White robust standard error. For dichotomous variables the marginal effect represents the probability change due to a shift from value of 0 to value of 1 (i.e. absence to presence of the attribute). Some of the coefficients, r.s.e. and marginal effects are scaled for convenience of display; these values are denoted by the scaling factor: $(10)^{-n}$. See Table 3 for variable definitions and unit of measures.

Source: Authors' computations based on Census of Agriculture 2001 and Census of Population 2001 data.

Table 9 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: full sample (average operator Pr(y=1) = 0.412)

Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Individual characteristics						
Age	0.434	0.00	-0.434	0.556	0.379	-0.176
Gender	0.429	0.367	-0.062	...	...	...
Less than high school (omitted)						
High school	0.368	0.464	0.096	...	...	...
University certificates	0.404	0.508	0.104	...	...	...
University degree	0.394	0.601	0.207	...	...	...
Family characteristics						
Presence of children	0.419	0.398	-0.021	...	...	...
Mobility	0.406	0.446	0.040	...	...	...
Unpaid housework	0.413	0.410	-0.003	...	...	...
Unpaid childcare	0.411	0.413	0.001	...	...	...
Unpaid senior care	0.414	0.388	-0.026	...	...	...
Farm characteristics						
One operator (omitted)						
Two operators	0.394	0.432	0.038	...	...	...
Three operators	0.409	0.439	0.029	...	...	...
Dairy (omitted)						
Cattle (Beef)	0.282	0.745	0.464	...	...	...
Hog	0.403	0.667	0.264	...	...	...
Poultry and egg	0.403	0.780	0.377	...	...	...
Wheat	0.386	0.830	0.444	...	...	...
Grain and oilseed (exc. Wheat)	0.323	0.768	0.445	...	...	...
Field crop (exc. Grain & oilseed)	0.371	0.828	0.457	...	...	...
Fruit	0.398	0.813	0.415	...	...	...
Miscellaneous specialty	0.344	0.813	0.470	...	...	...
Livestock combination	0.402	0.823	0.421	...	...	...
Vegetable	0.407	0.753	0.346	...	...	...
Other combination	0.402	0.793	0.391	...	...	...
Sole proprietorship (omitted)						
Partnership	0.418	0.401	-0.017	...	...	...
Corporation	0.429	0.328	-0.101	...	...	...
Area	0.435	1.000	0.565	0.417	0.338	-0.079
Capital	0.456	1.000	0.544	0.421	0.308	-0.113
Sales	0.415	0.000	-0.415	0.415	0.383	-0.032
Hired work	0.420	1.000	0.580	0.417	0.349	-0.068

(continued, see note on the following page)

Table 9 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: full sample (continued)

Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Local and regional characteristics						
Local employment growth	**0.388**	**0.451**	**0.063**	**0.408**	**0.415**	**0.007**
Regional employment growth	0.425	0.401	-0.024	0.414	0.410	-0.004
Local specialization	0.416	0.379	-0.036	0.414	0.410	-0.003
Regional specialization	**0.426**	**0.364**	**-0.062**	**0.417**	**0.406**	**-0.011**
Local unemployment	0.415	0.390	-0.025	0.413	0.411	-0.002
Regional unemployment	**0.425**	**0.289**	**-0.136**	**0.417**	**0.407**	**-0.010**
Employment structure						
Local manufacturing NRR	0.407	0.460	0.053	0.410	0.414	0.004
Regional manufacturing NRR	0.406	0.436	0.030	0.410	0.414	0.004
Local manufacturing LI	**0.400**	**0.716**	**0.316**	**0.403**	**0.421**	**0.019**
Regional manufacturing LI	**0.442**	**0.183**	**-0.260**	**0.430**	**0.394**	**-0.037**
Local manufacturing SB	**0.397**	**0.579**	**0.182**	**0.404**	**0.420**	**0.016**
Regional manufacturing SB	0.405	0.435	0.030	0.409	0.415	0.006
Local manufacturing PDSB	0.410	0.432	0.023	0.411	0.413	0.003
Regional manufacturing PDSB	**0.446**	**0.320**	**-0.126**	**0.424**	**0.400**	**-0.024**
Local distributive services	**0.387**	**0.477**	**0.091**	**0.408**	**0.416**	**0.008**
Regional distributive services	**0.439**	**0.385**	**-0.054**	**0.415**	**0.409**	**-0.006**
Local business services	**0.399**	**0.462**	**0.063**	**0.409**	**0.415**	**0.006**
Regional business services	**0.353**	**0.545**	**0.191**	**0.399**	**0.424**	**0.025**
Local consumer services	**0.368**	**0.489**	**0.120**	**0.406**	**0.418**	**0.012**
Regional consumer services	0.410	0.414	0.003	0.412	0.412	0.001
Local public services	**0.382**	**0.473**	**0.092**	**0.407**	**0.417**	**0.009**
Regional public services	0.405	0.425	0.019	0.411	0.413	0.003
Urbanization						
Distance to CMA/CA	**0.391**	**0.490**	**0.099**	**0.404**	**0.421**	**0.018**
Local population density	**0.414**	**0.268**	**-0.146**	**0.415**	**0.408**	**-0.007**
Regional population density	**0.417**	**0.318**	**-0.100**	**0.416**	**0.407**	**-0.009**

Note: "..." indicates that the computation is not applicable because the variable is dichotomous. For dichotomous variables, the minimum and maximum values are 0 and 1, respectively. For variables that have a quadratic term, the level and change of predicted probability include the effect of the quadratic term. For Area, Capital, Sales, and Hired work, $\alpha=0.1$ and $\lambda=0.9$; for all the other continuous variables $\alpha=\lambda=0.5$. Probabilities are evaluated by holding all other variables at their sample mean. See Table 4 for descriptive statistics (minimum and maximum values are not reported for confidentiality reasons). See Table 3 for variable definitions and unit of measures.
Source: Authors' computations based on estimation results, Census of Agriculture 2001 and Census of Population 2001 data.

Table 10 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: operator of smaller census-farm (average operator Pr(y=1) = 0.473)

Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Individual characteristics						
Age	**0.484**	**0.000**	**-0.484**	**0.647**	**0.435**	**-0.212**
Gender	**0.500**	**0.401**	**-0.100**	...	...	...
Less than high school (omitted)						
High school	**0.421**	**0.534**	**0.113**	...	...	...
University certificates	**0.463**	**0.590**	**0.127**	...	...	...
University degree	**0.453**	**0.672**	**0.219**	...	...	...
Family characteristics						
Presence of children	0.472	0.474	0.002	...	...	...
Mobility	0.472	0.479	0.008	...	...	...
Unpaid housework	**0.489**	**0.455**	**-0.034**	...	...	...
Unpaid childcare	0.474	0.471	-0.003	...	...	...
Unpaid senior care	**0.476**	**0.438**	**-0.038**	...	...	...
Farm characteristics						
One operator (omitted)	...	...	...	...	...	...
Two operators	**0.443**	**0.506**	**0.063**	...	...	...
Three operators	**0.468**	**0.552**	**0.084**	...	...	...
Dairy (omitted)						
Cattle (Beef)	**0.363**	**0.708**	**0.345**	...	...	...
Hog	**0.467**	**0.734**	**0.266**	...	...	...
Poultry and egg	**0.468**	**0.812**	**0.344**	...	...	...
Wheat	**0.451**	**0.790**	**0.340**	...	...	...
Grain and oilseed (exc. Wheat)	**0.398**	**0.766**	**0.368**	...	...	...
Field crop (exc. Grain & oilseed)	**0.442**	**0.759**	**0.317**	...	...	...
Fruit	**0.462**	**0.750**	**0.288**	...	...	...
Miscellaneous specialty	**0.421**	**0.741**	**0.320**	...	...	...
Livestock combination	**0.465**	**0.756**	**0.290**	...	...	...
Vegetable	**0.470**	**0.696**	**0.226**	...	...	...
Other combination	**0.466**	**0.709**	**0.243**	...	...	...
Sole proprietorship (omitted)						
Partnership	0.471	0.476	0.005	...	...	...
Corporation	**0.476**	**0.443**	**-0.033**	...	...	...
Area	**0.495**	**0.999**	**0.504**	**0.478**	**0.403**	**-0.075**
Capital	**0.484**	**0.846**	**0.362**	**0.474**	**0.456**	**-0.018**
Sales	**0.638**	**0.263**	**-0.375**	**0.449**	**0.304**	**-0.145**
Hired work	**0.477**	**0.905**	**0.428**	**0.473**	**0.461**	**-0.012**

(continued, see note on the following page)

Table 10 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: operator of smaller census-farm (continued)

Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Local and regional characteristics						
Local employment growth	**0.453**	**0.505**	**0.051**	**0.470**	**0.476**	**0.006**
Regional employment growth	0.481	0.466	-0.015	0.474	0.472	-0.002
Local specialization	0.479	0.416	-0.064	0.476	0.470	-0.006
Regional specialization	**0.502**	**0.374**	**-0.128**	**0.484**	**0.461**	**-0.023**
Local unemployment	0.476	0.452	-0.024	0.474	0.472	-0.002
Regional unemployment	**0.495**	**0.270**	**-0.226**	**0.481**	**0.464**	**-0.017**
Employment structure						
Local manufacturing NRR	0.471	0.493	0.022	0.472	0.474	0.002
Regional manufacturing NRR	**0.460**	**0.529**	**0.069**	**0.468**	**0.477**	**0.009**
Local manufacturing LI	**0.464**	**0.710**	**0.246**	**0.465**	**0.480**	**0.015**
Regional manufacturing LI	**0.510**	**0.169**	**-0.341**	**0.496**	**0.449**	**-0.047**
Local manufacturing SB	**0.465**	**0.552**	**0.087**	**0.469**	**0.477**	**0.008**
Regional manufacturing SB	0.473	0.472	-0.001	0.473	0.473	0.000
Local manufacturing PDSB	0.470	0.500	0.030	0.471	0.474	0.003
Regional manufacturing PDSB	**0.501**	**0.390**	**-0.111**	**0.483**	**0.463**	**-0.020**
Local distributive services	**0.455**	**0.519**	**0.064**	**0.470**	**0.476**	**0.006**
Regional distributive services	**0.505**	**0.440**	**-0.065**	**0.476**	**0.469**	**-0.007**
Local business services	0.465	0.501	0.036	0.471	0.475	0.004
Regional business services	**0.423**	**0.582**	**0.159**	**0.462**	**0.483**	**0.021**
Local consumer services	**0.446**	**0.518**	**0.072**	**0.469**	**0.476**	**0.008**
Regional consumer services	**0.521**	**0.409**	**-0.112**	**0.482**	**0.463**	**-0.019**
Local public services	**0.455**	**0.508**	**0.053**	**0.470**	**0.475**	**0.006**
Regional public services	0.483	0.454	-0.029	0.475	0.471	-0.004
Urbanization						
Distance to CMA/CA	**0.458**	**0.546**	**0.088**	**0.467**	**0.479**	**0.012**
Local population density	0.474	0.365	-0.109	0.475	0.470	-0.005
Regional population density	**0.478**	**0.380**	**-0.098**	**0.477**	**0.468**	**-0.009**

Note: "..." indicates that the computation is not applicable because the variable is dichotomous. For dichotomous variables, the minimum and maximum values are 0 and 1, respectively. For variables that have a quadratic term, the level and change of predicted probability include the effect of the quadratic term. For Area, Capital, Sales, and Hired work, α=0.1 and λ=0.9; for all the other continuous variables $\alpha=\lambda$=0.5. Probabilities are evaluated by holding all other variables at their sample mean. See Table 5 for descriptive statistics (minimum and maximum values are not reported for confidentiality reasons). See Table 3 for variable definitions and unit of measures.
Source: Authors' computations based on estimation results, Census of Agriculture 2001 and Census of Population 2001 data.

Table 11 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: operator of larger census-farm (average operator Pr(y=1) = 0.175)

Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Individual characteristics						
Age	0.279	0.031	-0.248	0.202	0.157	-0.045
Gender	**0.161**	**0.228**	**0.067**	...	...	...
Less than high school (omitted)	...	...	...	...	...	...
High school	**0.166**	**0.185**	**0.019**	...	...	...
University certificates	**0.172**	**0.204**	**0.032**	...	...	...
University degree	**0.168**	**0.255**	**0.087**	...	...	...
Family characteristics						
Presence of children	0.177	0.173	-0.004	...	...	...
Mobility	0.174	0.180	0.006	...	...	...
Unpaid housework	0.175	0.176	0.001	...	...	...
Unpaid childcare	0.175	0.175	-0.001	...	...	...
Unpaid senior care	0.176	0.162	-0.014	...	...	...
Farm characteristics						
One operator (omitted)	...	...	...	...	...	...
Two operators	**0.162**	**0.190**	**0.028**	...	...	...
Three operators	**0.168**	**0.202**	**0.033**	...	...	...
Dairy (omitted)	...	...	...	...	...	...
Cattle (Beef)	**0.149**	**0.364**	**0.215**	...	...	...
Hog	**0.163**	**0.295**	**0.132**	...	...	...
Poultry and egg	**0.161**	**0.415**	**0.254**	...	...	...
Wheat	**0.170**	**0.403**	**0.233**	...	...	...
Grain and oilseed (exc. Wheat)	**0.134**	**0.358**	**0.225**	...	...	...
Field crop (exc. Grain & oilseed)	**0.169**	**0.308**	**0.139**	...	...	...
Fruit	**0.172**	**0.358**	**0.185**	...	...	...
Miscellaneous specialty	**0.168**	**0.290**	**0.121**	...	...	...
Livestock combination	**0.174**	**0.288**	**0.115**	...	...	...
Vegetable	**0.173**	**0.278**	**0.105**	...	...	...
Other combination	**0.172**	**0.365**	**0.193**	...	...	...
Sole proprietorship (omitted)	...	...	...	...	...	...
Partnership	0.179	0.166	-0.013	...	...	...
Corporation	**0.190**	**0.159**	**-0.031**	...	...	...
Area	0.177	0.261	0.084	0.175	0.169	-0.006
Capital	**0.187**	**0.595**	**0.408**	**0.176**	**0.158**	**-0.022**
Sales	0.177	0.010	-0.167	0.176	0.163	-0.013
Hired work	**0.178**	**0.719**	**0.541**	**0.175**	**0.163**	**-0.012**

(continued, see note on the following page)

Table 11 Predicted probability of off-farm labour for selected values and changes of the explanatory variables: operator of larger census-farm (continued)

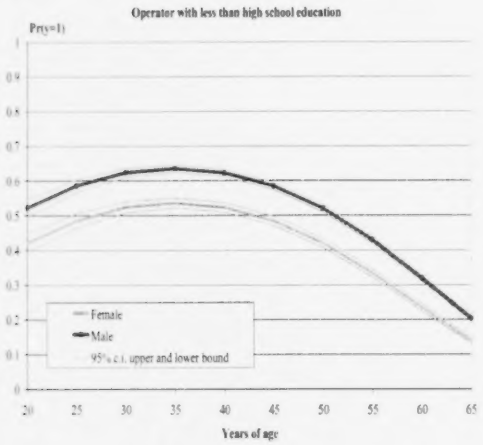
Variable	Pr(y=1) evaluated at		Δ Pr(y=1)	Pr(y=1) evaluated at		Δ Pr(y=1)
	x_{min}	x_{max}		$\mu-(\alpha \cdot sd)$	$\mu+(\lambda \cdot sd)$	
Local and regional characteristics						
Local employment growth	**0.141**	**0.221**	**0.080**	**0.170**	**0.180**	**0.010**
Regional employment growth	0.187	0.166	-0.021	0.176	0.174	-0.003
Local specialization	0.182	0.116	-0.066	0.178	0.172	-0.006
Regional specialization	0.178	0.164	-0.013	0.176	0.174	-0.002
Local unemployment	**0.196**	**0.062**	**-0.134**	**0.183**	**0.167**	**-0.016**
Regional unemployment	**0.161**	**0.353**	**0.192**	**0.170**	**0.181**	**0.011**
Employment structure						
Local manufacturing NRR	0.169	0.219	0.050	0.172	0.178	0.005
Regional manufacturing NRR	0.188	0.135	-0.053	0.179	0.171	-0.008
Local manufacturing LI	0.170	0.250	0.080	0.172	0.178	0.007
Regional manufacturing LI	**0.198**	**0.068**	**-0.130**	**0.187**	**0.164**	**-0.023**
Local manufacturing SB	0.170	0.233	0.063	0.173	0.177	0.005
Regional manufacturing SB	0.168	0.199	0.031	0.172	0.178	0.006
Local manufacturing PDSB	**0.185**	**0.113**	**-0.072**	**0.180**	**0.170**	**-0.009**
Regional manufacturing PDSB	0.168	0.189	0.021	0.173	0.177	0.005
Local distributive services	0.165	0.202	0.038	0.173	0.177	0.003
Regional distributive services	0.208	0.146	-0.062	0.179	0.171	-0.007
Local business services	**0.215**	**0.091**	**-0.124**	**0.184**	**0.166**	**-0.018**
Regional business services	0.144	0.267	0.124	0.167	0.183	0.016
Local consumer services	0.161	0.197	0.036	0.173	0.177	0.004
Regional consumer services	0.178	0.172	-0.006	0.175	0.175	-0.001
Local public services	0.161	0.206	0.045	0.173	0.177	0.004
Regional public services	0.183	0.158	-0.025	0.177	0.173	-0.003
Urbanization						
Distance to CMA/CA	0.159	0.421	0.262	0.167	0.181	0.014
Local population density	0.173	0.291	0.118	0.172	0.178	0.005
Regional population density	0.178	0.129	-0.050	0.178	0.172	-0.005

Note: "..." indicates that the computation is not applicable because the variable is dichotomous. For dichotomous variables, the minimum and maximum values are 0 and 1, respectively. For variables that have a quadratic term, the level and change of predicted probability include the effect of the quadratic term. For Area, Capital, Sales, and Hired work, α=0.1 and λ=0.9; for all the other continuous variables $\alpha=\lambda$=0.5. Probabilities are evaluated by holding all other variables at their sample mean. See Table 5 for descriptive statistics (minimum and maximum values are not reported for confidentiality reasons). See Table 3 for variable definitions and unit of measures.

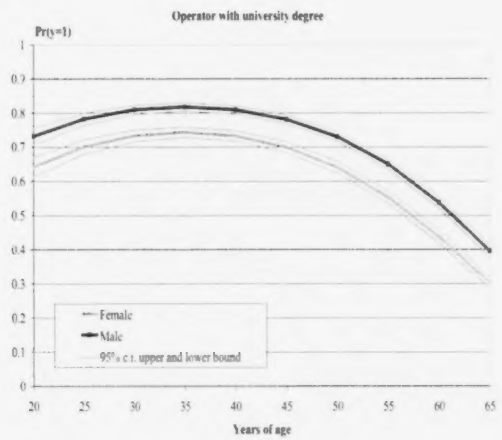
Source: Authors' computations based on estimation results, Census of Agriculture 2001 and Census of Population 2001 data.

Figure 1 Predicted probability of off-farm labour by gender and alternative education level: operators of smaller census-farms

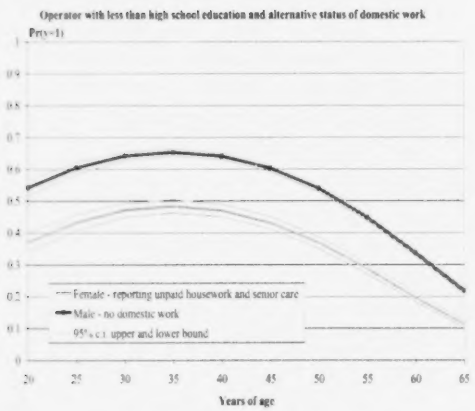
Panel A



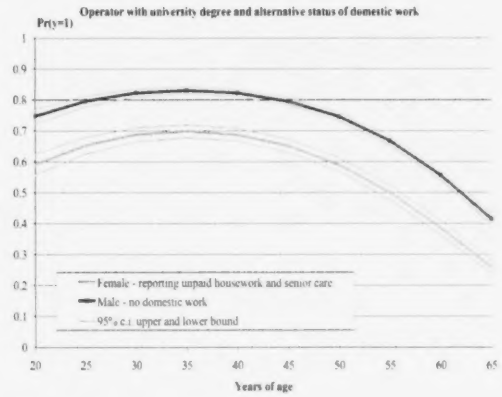
Panel B



Panel C


Operator with less than high school education and alternative status of domestic work
Pr(y=1)
Female - reporting unpaid housework and senior care
Male - no domestic work
95% c.i. upper and lower bound
Years of age

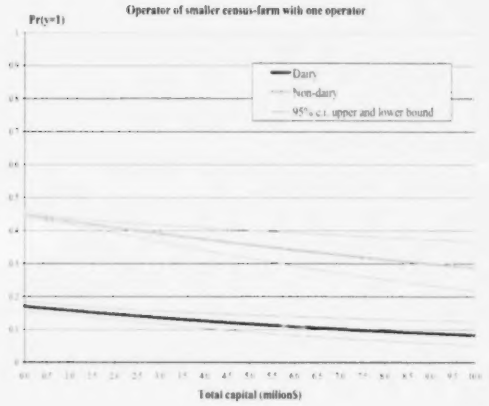
Panel D


Operator with university degree and alternative status of domestic work
Pr(y=1)
Female - reporting unpaid housework and senior care
Male - no domestic work
95% c.i. upper and lower bound
Years of age

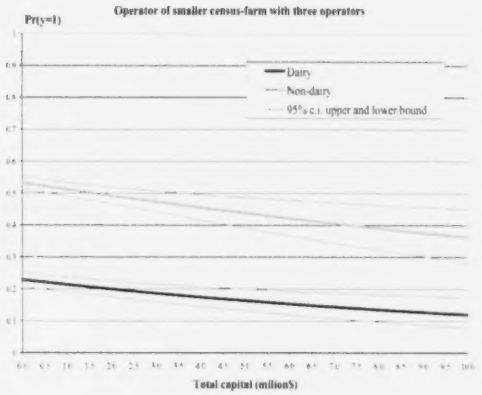
Note: Predicted probabilities are evaluated at sample mean of other explanatory variables.
Source: Authors' computation based on estimation results.

Figure 2 Predicted probability of off-farm labour and farm characteristics: operators of smaller and larger census-farms

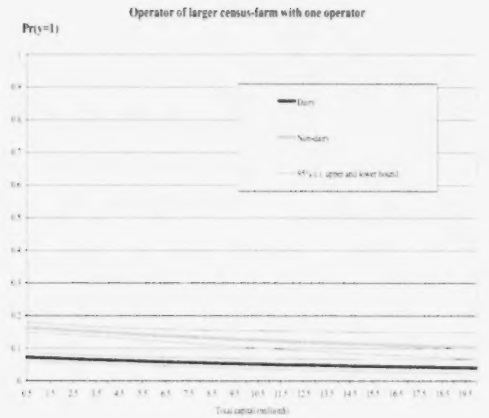
Panel A



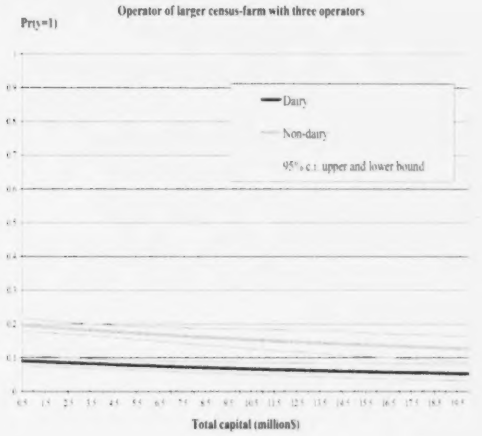
Panel B



Panel C



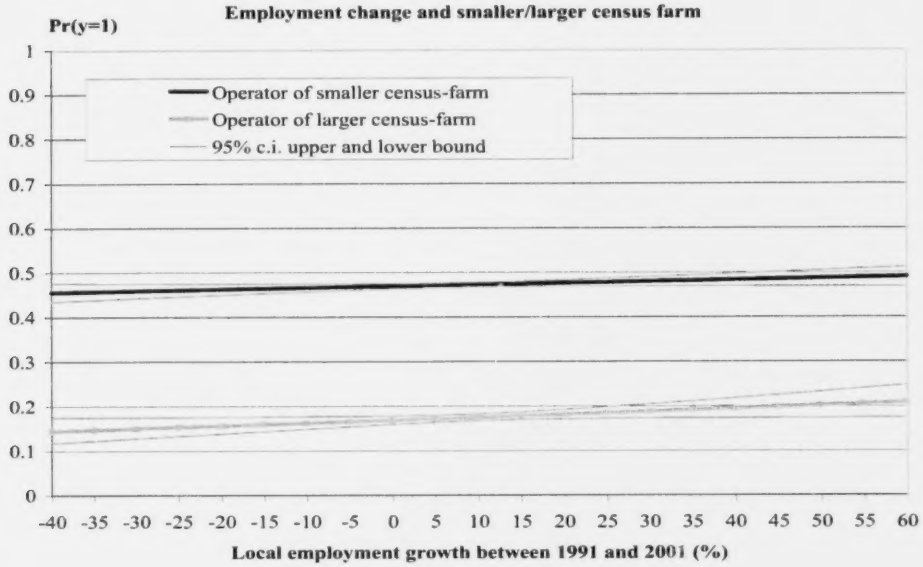
Panel D



Note: Predicted probabilities are evaluated at sample mean of other explanatory variables.
Source: Authors' computation based on estimation results.

Figure 3 Predicted probability of off-farm labour and labour market conditions

Panel A


Employment change and smaller/larger census farm
Pr(y=1)
Operator of smaller census-farm
Operator of larger census-farm
95% c.i. upper and lower bound
Local employment growth between 1991 and 2001 (%)

Panel B

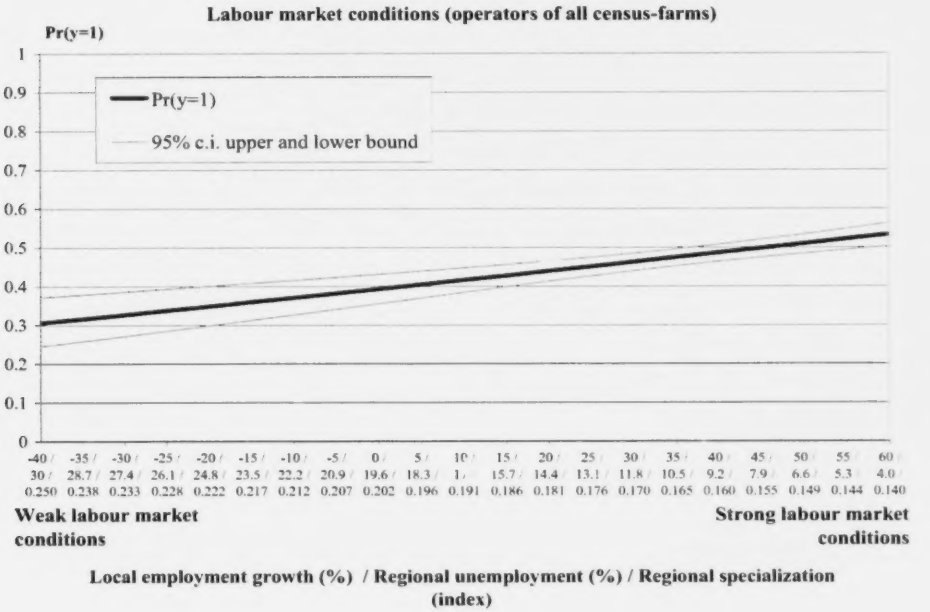
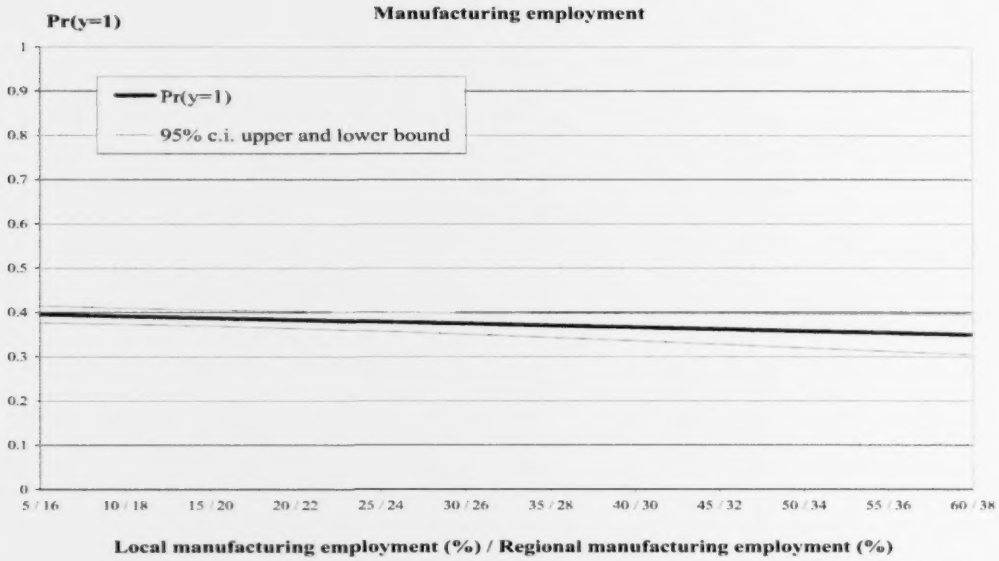

Labour market conditions (operators of all census-farms)
Pr(y=1)
Pr(y=1)
95% c.i. upper and lower bound
Weak labour market conditions
Strong labour market conditions
Local employment growth (%) / Regional unemployment (%) / Regional specialization (index)

Figure 4 Predicted probability of off-farm labour and manufacturing employment: operators of smaller census-farms

Panel A



Panel B

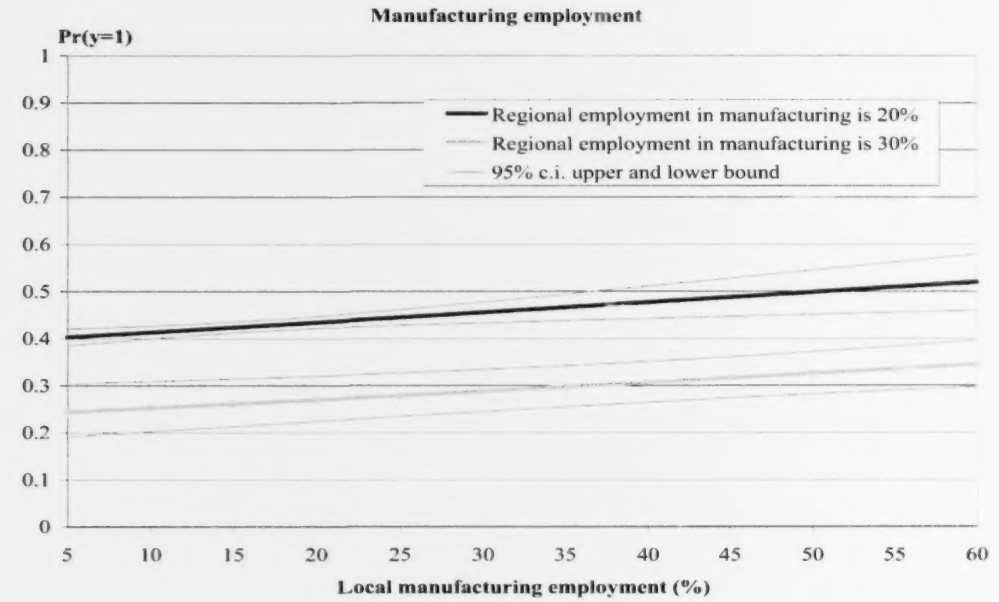
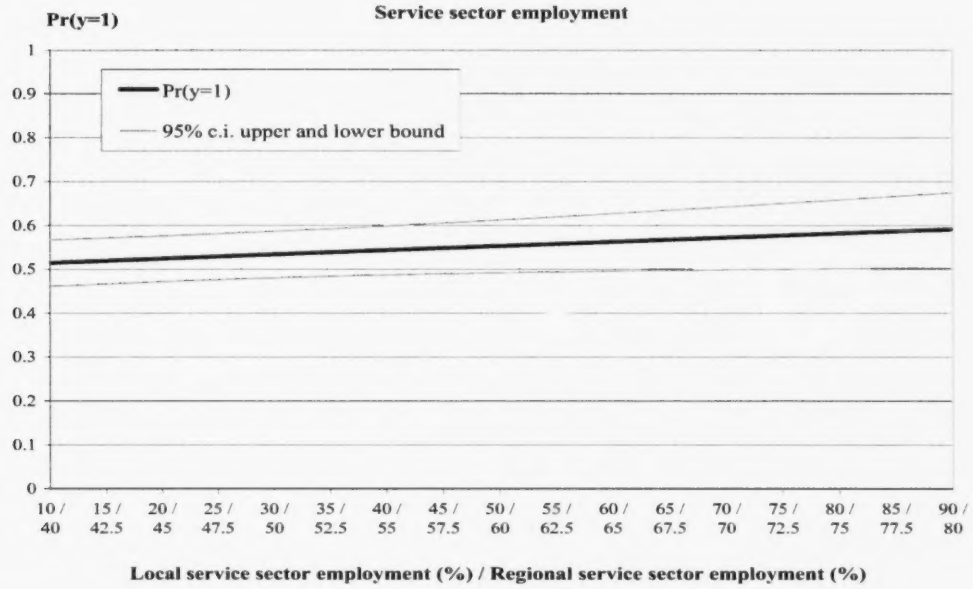


Figure 5 Predicted probability of off-farm labour and service sector employment: operators of small census-farms

Panel A



Panel B

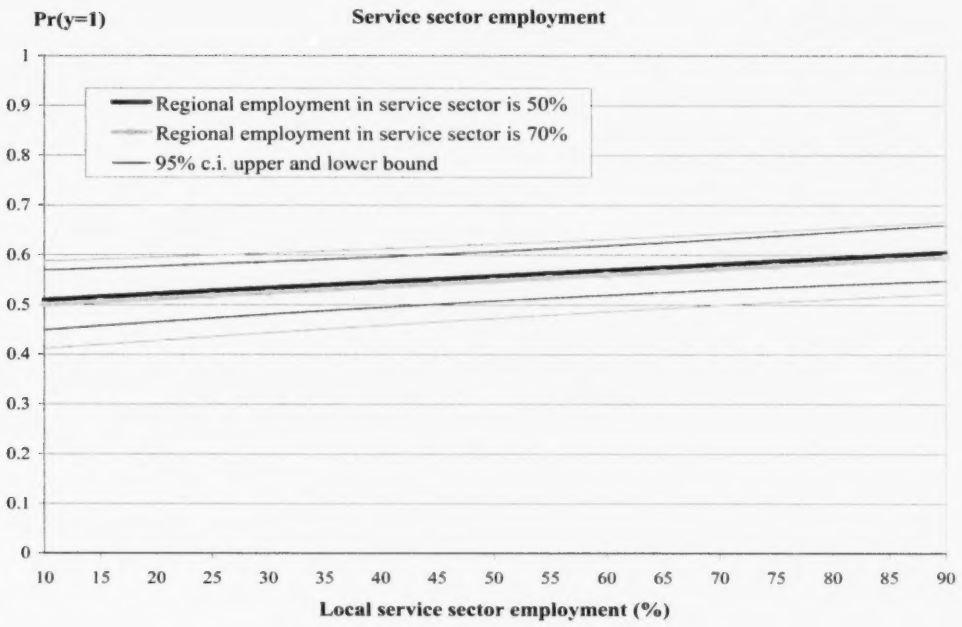
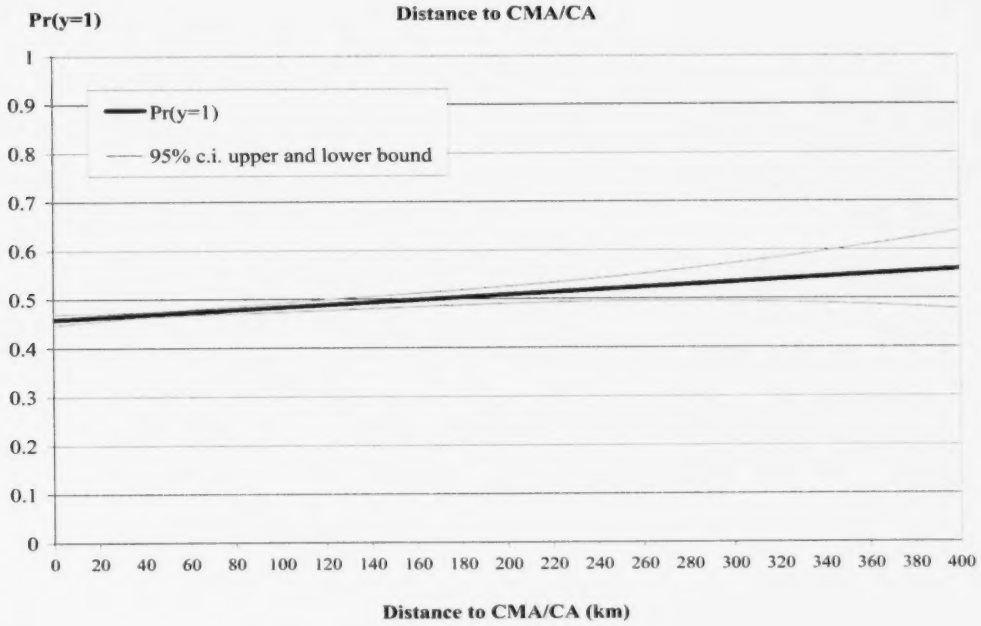
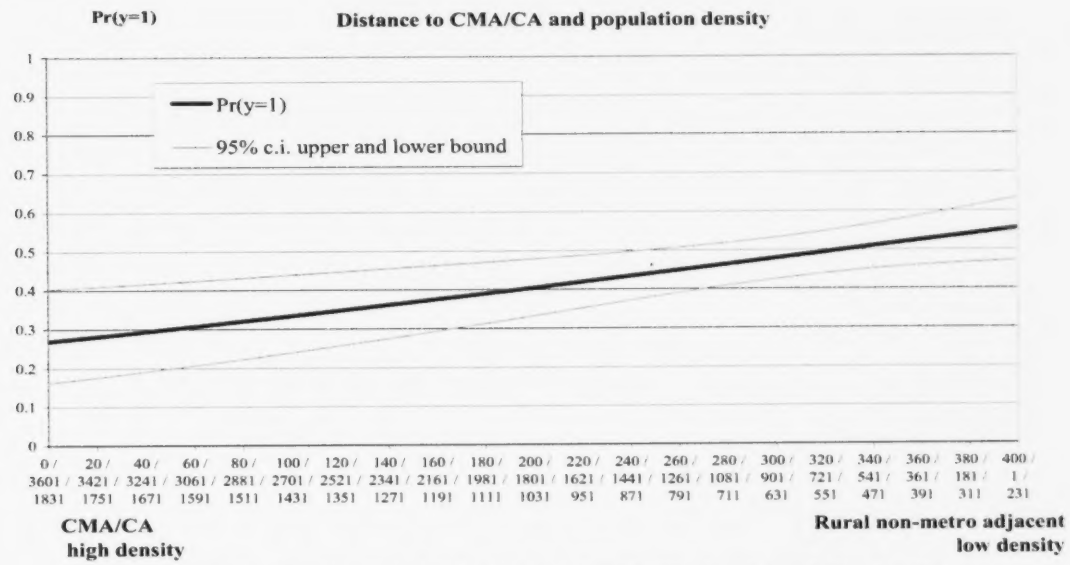


Figure 6 Predicted probability of off-farm labour and urbanization factors: operators of smaller census-farms

Panel A



Panel B



Map 1. Predicted probability of off-farm labour participation by agricultural weighting area

Note 1: Evaluated at sample mean of other explanatory variables.

Note 2: Predicted probabilities are computed for each observation in the sample and then are averaged at the agricultural weighting area level. Weighting areas are grouping of CCSs or Census Divisions, which are used for sampling and data reporting purposes by the Census of Agriculture. For details see: Fontaine (1998).

Source: Author's computation based on estimation results.

Map produced by the Remote Sensing and Geomatics Applications section (RSGA), Agriculture Division, Statistics Canada, 2007

Map 2. Effects of accelerated labour market dynamics on off-farm labour participation by agricultural weighting area

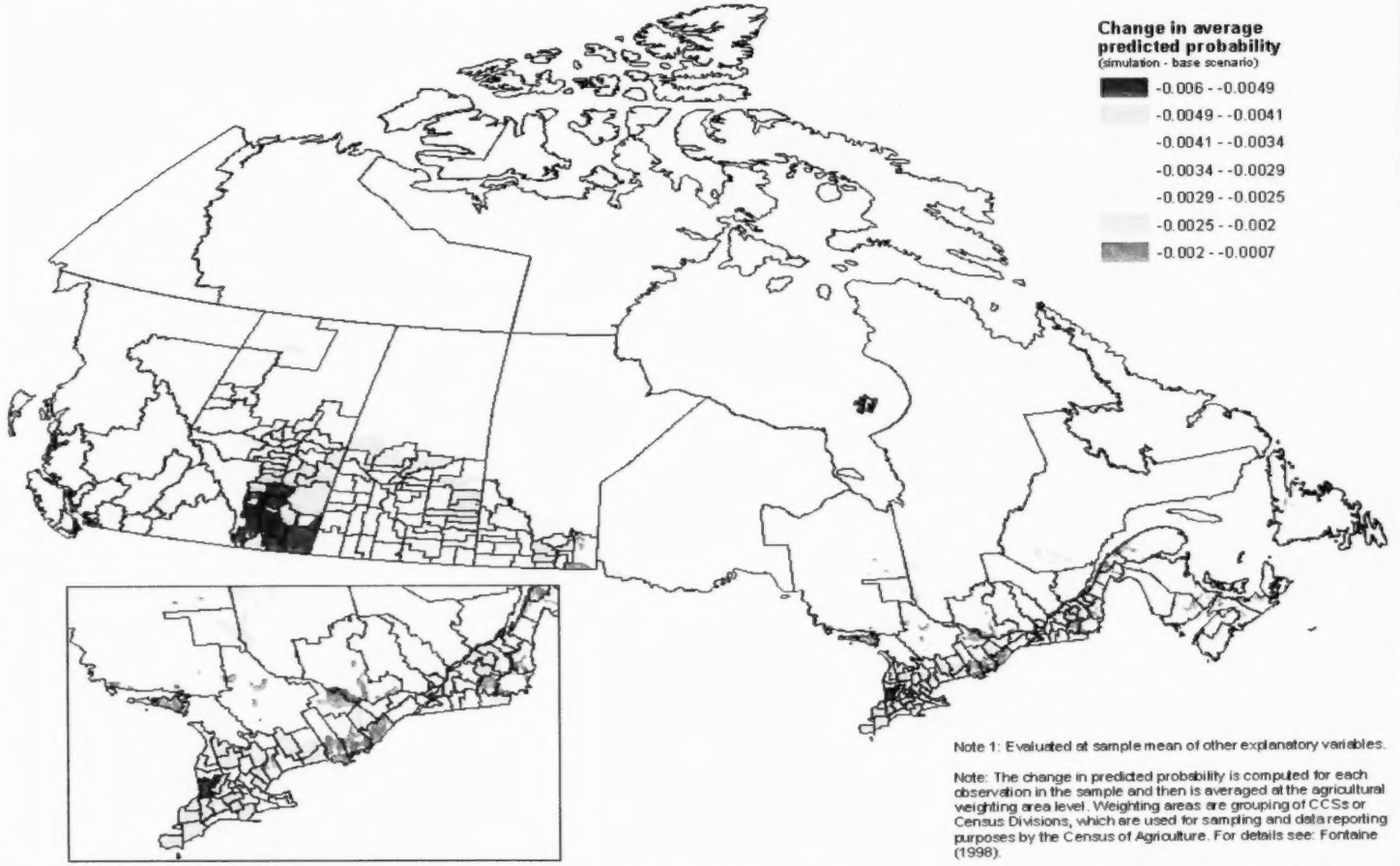
Note 1: Evaluated at sample mean of other explanatory variables.

Note 2: The change in predicted probability is computed for each observation in the sample and then is averaged at the agricultural weighting area level. Weighting areas are grouping of CCSs or Census Divisions, which are used for sampling and data reporting purposes by the Census of Agriculture. For details see: Fontaine (1998).

Source: Author's computation based on estimation results.

Map produced by the Remote Sensing and Geomatics Applications section (RSGA), Agriculture Division, Statistics Canada, 2007

Map 3. Effects of increasing farm size on off-farm labour participation by agricultural weighting area



Note 1: Evaluated at sample mean of other explanatory variables.

Note: The change in predicted probability is computed for each observation in the sample and then is averaged at the agricultural weighting area level. Weighting areas are grouping of CCSs or Census Divisions, which are used for sampling and data reporting purposes by the Census of Agriculture. For details see: Fontaine (1998).

Source: Author's computation based on estimation results.

Map produced by the Remote Sensing and Geomatics Applications section (RSGA), Agriculture Division, Statistics Canada, 2007

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